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The Sharks and Rays of California

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INTRODUCTION

This paper has been written to furnish a relatively simple means of distinguishing between the different kinds of sharks and rays in California and to establish official common names for each of these species. The names have been selected with considerable care, and with the help of several people, whose friendly cooperation it is a pleasure to acknowledge. Mr. W. L. Scofield of the California State Fisheries Laboratory has given much of his time to help settle the difficult problems of name selection. Marketmen and fishermen throughout the State cheerfully cooperated in giving information. Dr. Carl L. Hubbs of the Museum of Zoology, University of Michigan, and Dr. George S. Myers of the U. S. National Museum kindly criticized the manuscript and the names.

Professor Thomas Barbour, Director of the Museum of Comparative Zoology of Harvard University, gave permission to use the illustrations of the late Dr. Samuel Garman's work on sharks and skates. Dr. J. Frank Daniel of the University of California gave the photograph of the seven-gill shark.

Finally, the staff members of the California State Fisheries Laboratory have been exceedingly helpful in criticizing the manuscript, in giving suggestions, and in obtaining specimens for photography.

The following list is of books which were found most useful in compiling this work:

Garman, Samuel

1913. The Plagiostomia. Harvard College, Museum of Comparative Zoology, Memoirs, vol. 36, 528 pp., 77 pls.

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December, 1931.

COMMERCIAL USES OF SHARKS AND RAYS¹

There are 23 kinds of sharks and 15 kinds of rays recorded from the coast of California. Of these, about 12 of the former and eight or nine of the latter may be considered common enough to be caught almost any time; the rest are only occasional or rare visitors. Commercial fishermen, catching these fish only incidentally while fishing for other things, discard the greater part of the shark and ray catch as unmarketable, killing the fish and throwing them back into the sea. Sport fishermen, fishing in sloughs, along the shore from pleasure piers, and from pleasure boats, likewise often catch these fishes, and usually also cast them aside as worthless. This wastefulness is simply another sign of the great wealth of the country, which permits people to choose only the choicest morsels in the ocean and to destroy whatever else they find. As it becomes necessary for fishermen to look for more expensive species farther and farther away, as present trends indicate, it is possible that attention will be drawn to the cheaper grades of fish nearer home. It is characteristic of older fisheries centers, that the people utilize the marine products to a much greater extent than we of a new fishery center do. In Europe, for example, many sharks and skates bring almost as great a price in the markets as the other kinds of fishes, and shark liver oil is accepted as a satisfactory substitute for cod liver oil. In Asiatic countries, likewise, sharks and skates are important food fishes. On the Atlantic coast of the United States, shark skins are utilized in manufacturing leather. In Australia, besides taking sharks for their hides and for the manufacture of fertilizer, people find a rather large market for the teeth of some of the larger specimens, as ornaments. In California more use should be made of these fishes than is now done.

The form of the California species varies considerably from the fusiform, speedy-looking great blue shark, to the flat, bottom-living round sting ray. The hammerhead shark, the swell shark, the thresher, the manta, all have curious specializations of form. Some knowledge of the different kinds of these fishes will help one to understand their different uses and possibilities; for, of course, there is no uniformity of quality among the different species. Some may be useful for their hides, others for their oil—and the oils of different species are of different chemical constitution—others for their flesh, and some are of doubtful value for any purpose. The numbers and habits also vary. Most of the larger sharks are rare on our coast, and some of the rays which grow to large size are not taken in great quantity. Although there is unquestionably a fairly large population of these fishes in California, they do not at all compare in numbers with the bony fishes. None of the sharks or skates occurs in schools comparable in size or density to those of the California sardine, barracuda, mackerel, or yellowtail, for example. In planning a business of shark and skate

¹ This section, "Commercial uses of sharks and rays," has been published in *California Fish and Game*, vol. 19, no. 3, pp. 179-188, 1933.

utilization, therefore, it is important to remember this fact. Enthusiastic as people have become over the prospects of manufacturing various products from these fishes, they have found difficulty in getting sufficient material.

SHARKS AS FOOD

The use requiring the least investment, handling, and cost, of course, is food. While sharks and skates are not considered by some to be as fine as some of our other fishes, they should find a fairly large market among people who can not afford to pay the high prices demanded for such fishes as tuna, salmon and halibut. If properly prepared, some of the sharks, and many of the skates compare very favorably with more popular fishes. In fact, many people who "would never touch shark," frequently eat it and enjoy it under such names as "fillet of sole," "tenderloin of sole," "fillet," and even as "sturgeon!" Unfortunately, there is an old prejudice against sharks on the part of many people. The reason for this prejudice is the old belief that all sharks are inveterate man-eaters. This, of course, is absurd. If sharks had to depend for their living on eating people, there would be no sharks left, for there aren't enough people available in the water to feed a shark population. Besides, most of our sharks are rather small, with small teeth. Like most of our market fishes, they feed on smaller species of fishes and on invertebrates, which swarm the sea in unbelievable numbers. The largest of our sharks, the basking shark, eats only very tiny marine organisms. Although it is true that some sharks do attack human beings, most of these attacks are laid to one species, the great white shark, which is taken in California only rarely. Nevertheless, there is this superstitious prejudgment, and even though it is gradually being overcome by advertising, it is still in the way of making shark fishing for the markets a dependable venture. In California, sharks and skates are sold in fair numbers in the markets of San Pedro, and to some extent in San Francisco, but in the other fishing ports of the State, there is but slight demand for them. In San Pedro, the sharks are prepared by beheading, removing all the fins, cleaning, skinning, and finally filleting. As steaks, they appear in the retail markets, usually under the name of "fillet," and sell from 10 to 20 cents a pound (1931). Fishermen receive usually in the neighborhood of three cents a pound. Skates, which bring about the same price, are prepared for market by removing the head, gut and tail, leaving only the pectoral fins. They are sometimes filleted, sometimes sold under their own name. Both sharks and skates may be cooked like any other fish, without any special preparation.

SHARK FINS

Although shark fins are usually cut off and thrown away by fishermen and marketmen, they are much appreciated by Chinese, Filipinos and other oriental peoples, who pay as high as \$2.50 a pound retail for prepared fins. Several tons a year are imported from the west coast of Mexico, either to be shipped from California ports to the Orient or for local consumption. Sometimes fins are imported even from China for the American-Chinese trade. Merchants say that the demand for fins far exceeds the supply, as they are not only expensive, but often difficult to obtain. The wholesale price paid in 1931, from 15 cents to

\$1.50 a pound, while not enough to support a special industry, certainly gives opportunity of a profitable side line.

All fins are used, provided they are at least six inches long, though the tail fin is of slight value. The species of shark from which the fins are taken seems to be unimportant, so long as the fins are large enough and have good-sized cartilaginous rays in them.



FIG. 1. The cartilaginous rays from a shark fin, as sold in Chinatown, San Francisco. This is the part used by oriental people for making soup. Photo by L. A. Walford.

The preparation for the market is as follows: After the fins are cut from the body and the flesh cut entirely away, leaving only the fin, they are washed thoroughly in sea water. They are then spread out, preferably on chicken wire stretched two or three feet above the ground, and left in the sun for about 14 days until they are stiff and hard as a board. For the first few days the fins should be taken under shelter during the night to protect them from moisture. They must never, during the drying process, be stacked. After they are dried,

the fins should be packed in 200-pound lots in cases or barrels for shipment.

In preparing the fins for use, the Chinese soak them in warm water until the flesh softens and the cartilaginous rays can be separated out. These rays keep indefinitely when dried and are sold in retail stores. They are sliced up and boiled with chicken or other meat in the preparation of soup.

LEATHER FROM SHARKS

For many years, the only commercial use of shark skin was for making sword hilts and as an abrasive for polishing wood, ivory and other surfaces. Because these skins are covered with an armour of deeply imbedded hard scales, called shagreen, which are very difficult to remove, they could not compete with the skins of mammals in the commercial markets. In 1919 and 1920, Kohler and Tressler² separately developed and patented processes for removing this shagreen, thus opening up a new use for shark skins. These patents were assigned to the Ocean Leather Corporation of Newark, New Jersey, which seems at present to be the only producer of shark leather in the United States. Their product, known as *Eastern Shark Leather* and as *Olcotrop Shark Leather*, is used in manufacturing luggage, shoes and other leather goods, being superior in wearing qualities to ordinary leather, and of a very attractive appearance. The principal sources of supply are the fishing stations which this company has developed along the Gulf of Mexico, the Caribbean Sea and the West Indies. Although this firm receives some shark hides from the west coast of Mexico, these are not properly prepared.

Because they produce three different natural grains of leather, for the convenience of the trade, shark skins are divided into three classes: "eastern," "sawfish" and "nurse." Since this industry has not been introduced to the west coast and in the absence of special investigations, we can not tell which of our sharks are suitable for their skins. The leopard, the bonito and the hammerhead sharks, however, are similar to eastern forms and are classed by the Ocean Leather Corporation as "eastern sharks." There is no sawfish shark or nurse shark in California. Nevertheless, there are several kinds of California sharks which should provide hides comparable with the eastern species which the Ocean Leather Corporation lists. This company pays (1931) for skins according to size and condition, from about 25 cents each for hides measuring 25 to 34 inches from tip to tip, to around \$5 for those measuring 125 to 135 inches. A bonus is given for perfect hides having no holes or no sour (rotten) spots; deductions are made for holes and sour spots, and hides having many holes and sour spots over the entire surface are not accepted.

DIRECTIONS³ FOR PREPARING SHARK HIDES

Skinning

It is very important that the shark be skinned as soon as possible after being caught. Since any shark will spoil within twenty-four hours, the hides as well as the by-products have to be prepared and cured within a few hours after the shark is removed from the water.

² Tressler, Donald K. Marine products of commerce. New York, 1923, p. 494.

³ Supplied by the Ocean Leather Corporation, Newark, New Jersey.

It is important to avoid exposure to the sun and to keep hides or any shark products from coming in contact with fresh water.

The first operation is to remove with a sharp knife all the fins and the tail, cutting in a curve into the fins, in order to leave little or no meat or skin on the fins. The tail is to be cut completely off just above the root. The fleshy part of the fins, which now remains, should then be trimmed off as close as possible to the carcass. (See Figs. 2 and 3.)

The second operation is to insert the knife, which should be very sharp, in the holes made by removing the dorsal fins and to split the

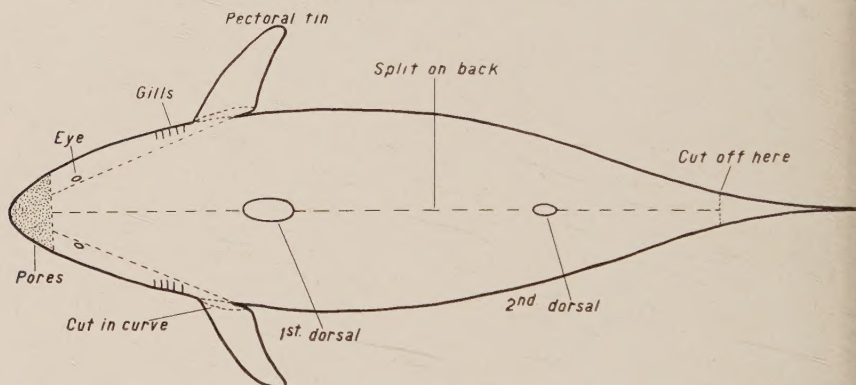


FIG. 2. Diagram of a shark's back. The dotted lines show where to cut in preparing for skinning. Modified from a bulletin issued by the Ocean Leather Company.

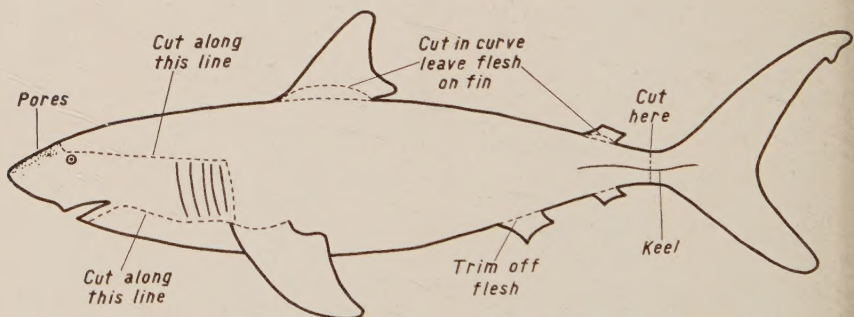


FIG. 3. Diagram of the side of a shark. The dotted lines show where to cut in preparing for skinning. Modified from a bulletin issued by the Ocean Leather Company.

hide along the back as straight as possible, first toward the tail end to where the tail has been cut off, then toward the head to a point where the head is perforated with numerous small pores. On some species these pores begin five or six inches from the tip of the snout. Then from here, cut (on each side) toward the undersurface of the fish to a point in line with the eyes and top of the gills; then cut toward the pectoral fins, passing just above the eyes and just above the gills, until the holes made by removing the pectoral fins are reached. Now proceed to cut again in the direction of the jaws passing this time just below the gills. Lay the shark on its back and proceed to cut toward the lower jaw, and cut along the rim of the mouth, keeping

an inch or two from the edge. These two cuts, one on each side, will meet midway under the mouth, and this part of the hide constitutes the chin flap.

The third operation is the actual skinning. Turn the carcass on its belly and straddle the back, facing in the direction of the head. Take in the left hand the left side split of the section of the hide near the head, holding firmly while the right hand operates the skinning knife, which must be very sharp, and peel the hide off by cutting away the carcass. To avoid cutting the hide, great care must be taken in operating the skinning knife. Since too close skinning may easily result in accidental cuts, it is easier to leave considerable flesh on the hide and to remove this later by fleshing. After the left side is skinned, turn around facing the tail end, and skin the other side in the same manner as before. The left hand should always keep the hide pulled tight while skinning in order to avoid cutting holes in the skin. After

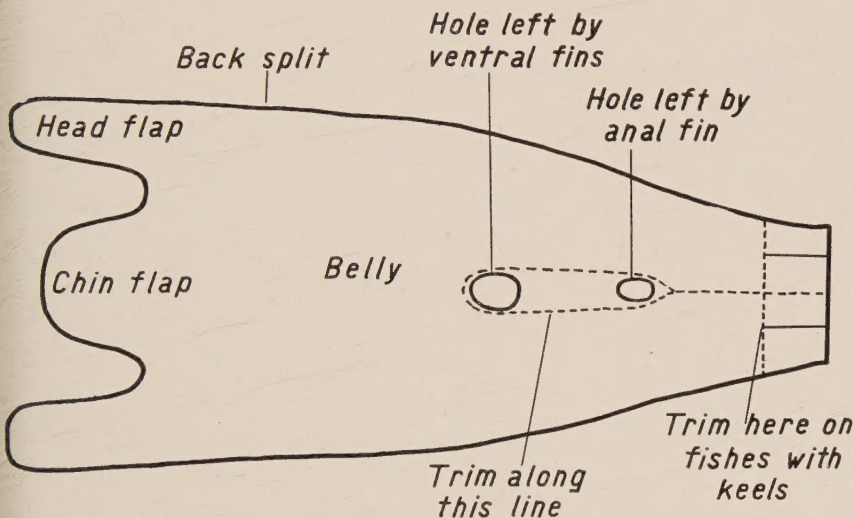


FIG. 4. Diagram showing the hide after being stripped from the shark. From a bulletin issued by the Ocean Leather Company.

the hide is removed, it must be washed thoroughly in sea water to remove all the blood and slime.

Fleshing the Hide.

The next operation is to remove all the surplus flesh. This is done with a beaming knife on a beaming board. The beaming knife is a large curved knife with a handle on each end. The beaming board is a surface curved to correspond with the curve of the beaming knife, about 6 feet long and about $3\frac{1}{2}$ feet wide. One end rests on the floor, the other having a support about the height of a man's waist. The board must be perfectly smooth, and it is important never to permit particles of meat or other substance to get between the board and the hide. In fleshing, the hide must be kept smooth on the board.

If the hides can not be fleshed at once, they should be put in brine immediately, where they may be kept not longer than 12 hours,

and preferably not more than two or three hours. The brine should be strong enough to float a potato about 4 inches long.

Trimming the Hide.

After fleshing, while the hide is still on the beaming board, it should be trimmed. The outer edges, the sharp corners and the small meat particles which may hang over after fleshing, should be cut off. The hide must be split in the tail end by cutting from the hole left by the ventral fin, straight back to where the tail has been cut off, passing through the hole left by the anal fin. (See Fig. 5.) If the shark has keels on the caudal peduncle, these should be cut off. After the fleshing and trimming, the hides must be thoroughly washed in sea water to remove all blood, slime, dirt and clinging flesh. No blood or slime should remain on the hides. They should then be salted for curing.

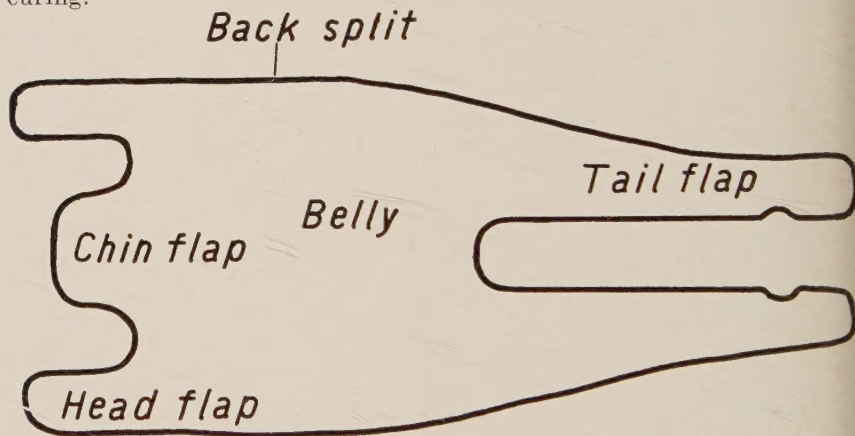


FIG. 5. The hide after being trimmed. From a bulletin issued by the Ocean Leather Company.

Curing

The curing is done in the following manner: Sprinkle plenty of medium grain fishery salt on the platform or floor where the hides will be laid. Then, after laying one hide out flat, flesh side up, taking care to smooth out the wrinkles, sprinkle salt so as to cover liberally every part of the surface. On top of this hide put the next one, flesh side up, and salt in the same manner, and so on. It is preferable to lay the hides on a platform which has a slight incline, which will permit the water and brine to run off. The pile of hides should be built up as evenly as possible, without any lumps or depressions, and kept well-salted. Large hides take about eight days to cure in this salt pile; small hides about five or six days. While curing, the hides must not be exposed to the sun or come in contact with rain or other fresh water.

Before the hides are packed for shipment, they should be measured. This is done by folding lengthwise, and measuring from tip to tip.

Packing for Shipment

The hides are prepared for shipment in the following manner: After shaking each piece lightly to remove the surplus salt, lay it on

the floor, flesh side up, sprinkle the entire surface with dry salt, and fold so as to make it a flat square bundle. Because of possible leakage of brine en route, some transportation companies require the hides to be packed in water-tight barrels. A 55-gallon barrel will hold about 25 average-sized shark skins. The weight will be about 275 pounds net.

After the hides reach the factory, they are tanned, the shagreen is removed and they are colored and finished.⁴

SHARKS FOR THE MANUFACTURE OF FISH MEAL

At only three ports—San Diego, Monterey and San Francisco—were sharks sold to reduction factories in past years, and then in relatively small quantities, merely the incidental catches of fishermen. At these places the sharks were mixed with the fish offal of canneries and from markets and manufactured into fertilizer. Fishermen received around \$5 a ton for the sharks.

SHARK LIVER OIL

The livers of many sharks and rays have a very high oil content. The most important use for this oil is for the curing of leather in the shark industry. The more highly unsaturated oils are used in making tarpaulins and other oiled cloths. Sometimes they are used in the manufacture of low grade soaps, in the tempering of steel, and sometimes are mixed with vegetable paint oils. In Greenland, because

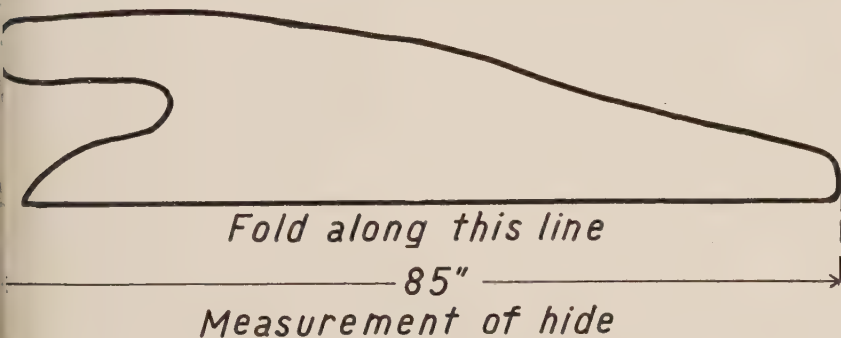


Fig. 6. Showing how to measure the hide in estimating its value. From a bulletin issued by the Ocean Leather Company.

petroleum is not permitted in the houses owing to the danger of fire, shark oil is used for illuminating purposes. In Europe, parts of Asia, and sometimes in the United States, shark liver oil is sold as a substitute for cod liver oil. Since different sharks produce different grades of oil, it is necessary to analyze chemically the product derived from each species in order to be able to compare it with cod liver oil. Although it has already been demonstrated that the oil from the liver of the basking shark is not particularly rich in vitamins, it is claimed by some people to have medicinal properties of its own. Perhaps the vitamins are present in the livers but are broken down during the extraction, and possibly improved methods will preserve them.

⁴ For a description of these processes, see Tressler, *op. cit.*, pp. 495-499.

SHARK FISHING METHODS ON THE EAST COAST

It is evident that if one plans to make a business of shark fishing, he must not only utilize every part of the shark but he must develop highly specialized methods for catching his material. On the east coast, two methods are employed: long lines and gill nets.

Long Lines

A line of hemp rope of suitable length, say 500 yards,⁵ is buoyed up at intervals with kegs. At each interval of about 12 or 14 feet, a ganging line provided with wire leader and baited hook is attached. The line must be tended regularly by a boat prepared to kill and haul aboard the shark as soon as it bites. A shark caught on a hook is likely to be attacked by other sharks and destroyed.

Gill Nets⁶

These are usually 200 yards long, when hung, and about 15 meshes deep. The webbing is made of number 72 medium cotton twine, the meshes being from 7 to 12 inches when stretched. The cork and lead lines are seven-sixteenths of an inch, steam-tarred manila rope. The corks are English net corks, 4 inches in diameter, and are placed after every third mesh.

These nets are set on the bottom, weighted with 50-pound galvanized stock anchors, with about 10 fathoms of anchor ropes, at least three-fourths of an inch in diameter. A small buoy is fastened to one anchor; a flag buoy as a marker to the other. The net itself should also have a small buoy on each end. The length of the buoy ropes, which are of the same material as the lines on the net, depends on the depth of the water where the net is to be set. It is always better to have the

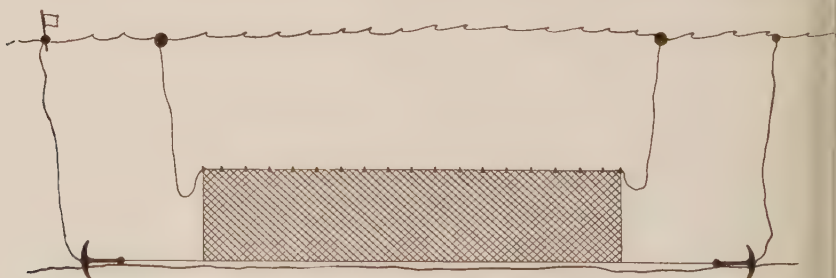


FIG. 7. Diagram showing special type of net used to catch sharks on the Atlantic Coast. From a bulletin issued by the Ocean Leather Company.

buoy ropes a little longer than absolutely necessary. In order to hoist sharks out of the nets, it is advisable to use a large steel hook with an eye or handle.

SHARK FISHING METHODS IN CALIFORNIA

In this State, sharks are taken with hook and line, with set and long lines, and in all kinds of nets. They are a pest to gill net fishermen, as they swim into the nets, thrash about in trying to extricate

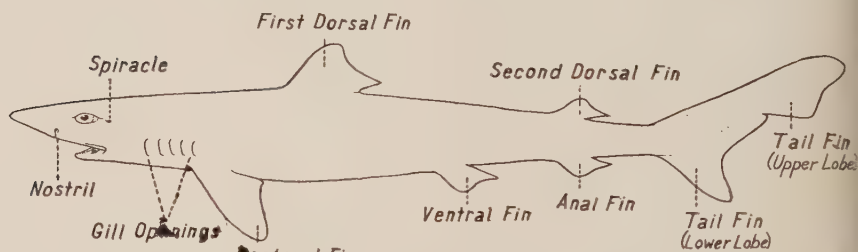
⁵ From the Fishing Gazette, New York, November, 1923.

⁶ Information supplied by the Ocean Leather Company, Newark, New Jersey.

themselves, roll up, and often cause great damage to the nets, besides occasioning much loss of time to the fishermen who can remove them only with difficulty.

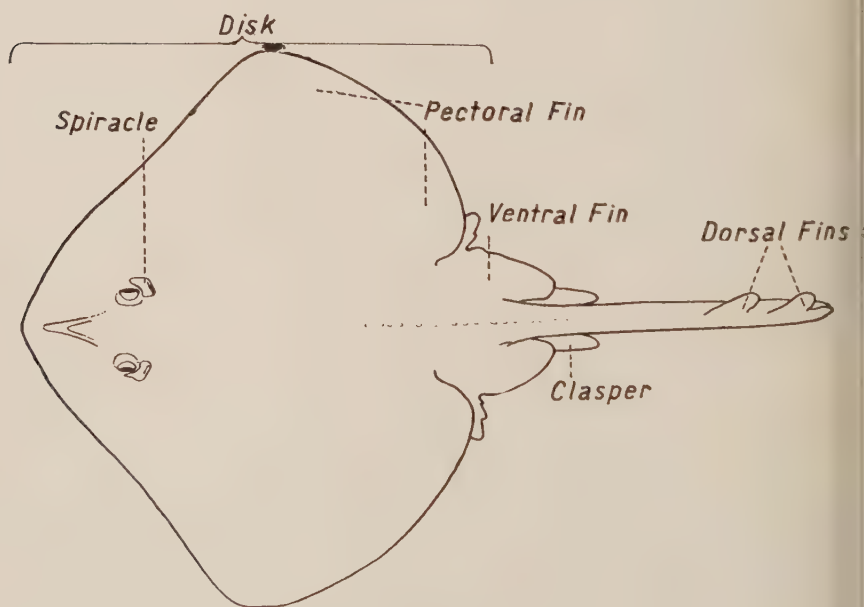
Because of the strain on our other fish populations, as well as because of the damage done by sharks to nets, it would seem to be to the fishermen's interest to attempt to develop a greater shark fishery, if only to relieve the strain and to cut down the shark population. Whether special fishing methods can overcome the difficulty in obtaining enough material to work with to support a special fishery remains for some enterprising pioneer to discover. Meanwhile, there is no reason why a fuller use should not be made of the many sharks now incidentally taken and wastefully destroyed.

ILLUSTRATIONS OF ANATOMICAL TERMS



Drawing from Starks, 1921.

FIG. 8. Example of a shark.



Drawing from Starks, 1921

FIG. 9. Example of a ray.

GLOSSARY OF ANATOMICAL TERMS

(NOTE.—See drawings on page 14 for illustrations of these terms.)

ANAL FIN: The unpaired fin on the mid-line of the under side of the body, just behind the vent.

CARTILAGE: Firm elastic tissue, softer than bone, which forms the skeletal structure of sharks and rays.

CAUDAL FIN: The tail fin.

CAUDAL PEDUNCLE: That part of the body behind the anal fin which holds the tail fin. The root of the tail.

DEPTH: The greatest vertical diameter of a fish.

DISK: The flat, more or less round part of rays, which consists of the body and pectoral fins.

DORSAL: The back or upper part of the body. Opposite to **VENTRAL**. Sometimes refers to the **DORSAL FIN**.

DORSAL FIN (sometimes called **THE DORSAL**): The unpaired fin or fins on the mid-line of the back.

GILL SLITS: The external openings leading to and from the gills.

GILLS: The respiratory apparatus of fishes, found within the gill openings.

KEEL: Sharp, ridge-like projections on the caudal peduncle.

OVOVIPAROUS: Spoken of fish which produce eggs that have a well-developed covering or shell but which hatch within the body of the parent.

PECTORAL FINS (also called **PECTORALS**): The first or upper of the paired fins.

SNOUT: That part of the head in front of the eyes.

SPIRACLES: Small openings in the upper part of the head or neck of some sharks and rays.

VENT: The opening at the posterior end of the digestive tract.

VENTRAL: Relating to the underside of the body. The opposite of **DORSAL**. Sometimes refers to the **VENTRAL FIN**.

VENTRAL FINS: The paired fins placed behind or below the pectoral fins.

VIVIPAROUS: Spoken of fish which give forth living young (instead of eggs) from within the body, as nearly all mammals do.

KEY TO THE IDENTIFICATION OF SHARKS AND RAYS FOUND IN CALIFORNIA (INCLUDING THE RATFISH)

NOTE.—To use this self-directing key, simply read the first section, where you will find further directions. The key is applicable only to California species. Technical anatomical terms are explained in the drawings on page 14, and in the glossary.

1. IF: There are from 5 to 7 pairs of gill openings, *see* section 2.
 BUT IF: There is only 1 pair of gill openings, and the skeleton is of cartilage (instead of bone), the fish is a Ratfish (*Hydrolagus collieti*). (*See* page 63.)
 * * * *
2. IF: The gill openings are situated at least partly on the side of the body, *see* section 3.
 BUT IF: The gill openings are entirely on the under surface of the body, *see* section 24.
 * * * *
3. IF: There are 6 or 7 gill openings, *see* section 4.
 BUT IF: There are 5 gill openings, *see* section 5.
 * * * *
4. IF: There are 7 gill openings, the fish is a Seven-Gill Shark (*Notorynchus maculatus*). (*See* page 23.)
 BUT IF: There are 6 gill openings, the fish is a Six-Gill Shark (*Hexanchus corinus*). (*See* page 24.)
 * * * *
5. IF: An anal fin is present, *see* section 6.
 BUT IF: No anal fin is present, *see* section 22.
 * * * *
6. IF: There is a spine in the fore part of each dorsal fin, the fish is a Horned Shark (*Heterodontus francisci*). (*See* page 25.)
 BUT IF: The dorsal fins are without spines, *see* section 7.
 * * * *
7. IF: The first dorsal fin is situated in front of the ventral fins, *see* section 10.
 BUT IF: The first dorsal fin is not situated in front of the ventral fins, being above or behind them, *see* section 8.
 * * * *
8. IF: There is a fold of skin around the angle of the mouth (labial fold), and the body is without black spots, *see* section 9.
 BUT IF: There is no well-defined fold of skin around the corner of the mouth and the body is marked with blackish spots, the fish is a Swell Shark (*Cephaloscyllium uter*). (*See* page 28.)
 * * * *
9. IF: The part of the fold of the skin (labial fold) on the lower jaw is about twice as long as that on the upper jaw; there is a broad band of enlarged rough scales (except in young) on the upper edge of the tail, and the belly is pale, the fish is a File-tail Shark (*Parmaturus xanthurus*). (*See* page 27.)

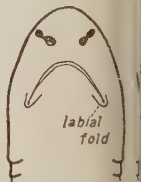


FIG. 10.

BUT IF: The part of the fold of the skin on the lower jaw (labial fold) is slightly shorter than that on the upper; the upper edge of the tail is without enlarged scales, and the belly is not pale, the fish is a Brown Shark (*Scyliorhinus brunneus*). (See page 26.)



FIG. 11.

* * * *

10. IF: There is no keel on the side of the root of the tail, see section 11.

BUT IF: There is a keel on each side of the root of the tail, see section 19.

* * * *

11. IF: The tail fin is less than $\frac{1}{2}$ the total length of the body, see section 12.

BUT IF: The tail is exceedingly long, about as long as the rest of the body, the fish is a Thresher (*Alopias vulpes*). (See page 41.)

* * * *

12. IF: The head is singularly formed, being mallet-shaped, from the extension of its sides, the fish is a Hammerhead Shark (*Sphyrna zygaena*). (See page 40.)

BUT IF: The head is normally formed, see section 13.

* * * *

13. IF: The teeth are very blunt, flat, and pavement-like, without points (when the finger is passed over the teeth from behind forward, no points may be felt), the fish is a Gray Smooth-hound (*Mustelus californicus*). (See page 29.)

BUT IF: The teeth have more or less raised points, or are more or less knife-like, see section 14.

* * * *

14. IF: Spiracles are present, see section 15.

BUT IF: Spiracles are absent, see section 18.

* * * *

15. IF: The teeth all have saw-toothed edges (see Fig. 12), as well as a deep notch in their outer margins, the fish is a Tiger Shark (*Galeocerdo arcticus*). (See page 35.)



FIG. 12.

BUT IF: The edges of each individual tooth are not saw-toothed, see section 16.

* * * *

16. IF: The side of the body is marked with blackish crossbars and spots, the fish is a Leopard Shark (*Triakis semifasciata*). (See page 32.)

BUT IF: The color is plain, the body being without crossbars or spots, see section 17.

* * * *

17. IF: The teeth are low, with low, sharp points (which may be noticed when the finger is passed over the teeth from behind forward), and occur in from 5-7 rows, the fish is a Brown Smooth-hound (*Rhinotriakis henlei*). (See page 30.)

BUT IF: The teeth are noticeably sharp, rather knife-like, and occur in 2-4 rows, the fish is a Soupfin Shark (*Galeorhinus zyopterus*). (See page 31.)

* * * *

18. IF: The front of the first dorsal fin is nearer the base of the ventral fins than to the base of the pectoral fins, the fish is a Great Blue Shark (*Prionace glauca*). (See page 34.)

BUT IF: The front of the first dorsal fin is nearer the base of the pectoral fins than to the base of the ventral fins, the fish is a Bay Shark (*Carcharias lamiella*). (See page 33.)

19. IF: The gill slits are very large, nearly meeting under the throat, and the teeth are small, numerous and conical, the fish is a Basking Shark (*Cetorhinus maximus*). (See page 39.)



FIG. 13.

BUT IF: The gill slits do not nearly meet at the throat, and the teeth are more or less compressed, see section 20.

* * * *

20. IF: The teeth are triangular and have saw-toothed edges (see Fig. 14), the fish is a Great White Shark (*Carcharodon carcharias*). (See page 38.)
- BUT IF: The edges of the teeth are smooth, see section 21.



FIG. 14.

* * * *

21. IF: The front of the first dorsal fin is above the root of the pectoral fins, the fish is a Mackerel Shark (*Lamna cornubica*). (See page 37.)

BUT IF: The front of the first dorsal fin is behind the root of the pectorals, the fish is a Bonito Shark (*Isurus glaucus*). (See page 36.)

* * * *

22. IF: The pectoral fins are exceedingly enlarged, and expanded horizontally, giving the fish the disk-like appearance of the rays, and the gill-openings are crowded together in a deep notch behind the head, the fish is an Angel Shark (*Squatina californica*). (See page 44.)

BUT IF: The pectoral fins are normally developed, and the gill openings are normally placed, as in other sharks, see section 23.

* * * *

23. IF: There is a spine in the fore part of each dorsal fin, the fish is a Grayfish (*Squalus suckleyi*). (See page 42.)

BUT IF: The dorsal fins are without spines, the fish is a Sleeper Shark (*Somniosus microcephalus*). (See page 43.)

* * * *

24. IF: There are 2 dorsal fins, see section 25.

BUT IF: There is only 1 dorsal fin, or none at all, see section 34.

* * * *

25. IF: The skin is everywhere smooth, without spines or prickles, the fish is an Electric Ray (*Tetronarce californica*). (See page 57.)

BUT IF: The skin is not perfectly smooth, but has more or less rough scattered prickles and spines, see section 26.

* * * *

26. IF: A tail fin is present, see section 27.



FIG. 15.

BUT IF: A tail fin is absent, or is represented only by a slight fold of skin, see section 29.

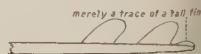


FIG. 16.

* * * *

27. IF: The snout is obtuse, the width of the disk being not less than the length, see section 28.

BUT IF: The snout is acute, the width of the disk being noticeably less than the length, the fish is a Pointed-nosed Guitar Fish (*Rhinobatus productus*). (See page 45.)

* * * *

28. IF: The first dorsal fin is situated at about the middle of the tail, and the skin is covered with fine shagreen (that is, having the quality of fine sandpaper) with some spines at the front margin of the disk, on the snout and down the mid-line of the back, the fish is a Thornback (*Platyrrhinoidis triseriatus*). (See page 47.)

BUT IF: The first dorsal fin is situated in advance of the middle of the tail, and the skin is everywhere covered with irregular scattered tubercles and prickles, with enlarged spines on the shoulders, middle of back and tail, the fish is a Striped Guitar Fish (*Zapteryx exasperata*). (See page 46.)

* * * *

29. IF: There are large areas on the upper surface which are smooth, or if the upper surface is covered with very fine prickles, giving to the skin the roughness of fine sandpaper, see section 30.

BUT IF: There are no large smooth areas on the upper surface, the skin being very rough, like very coarse sandpaper, see section 32.

* * * *

30. IF: The outer margins of the ventral fins when held at right angles to the tail are deeply concave, see section 31.

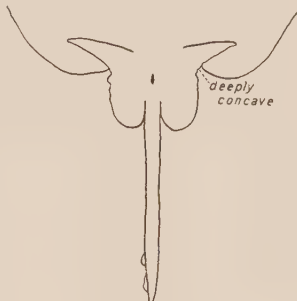


FIG. 17.

BUT IF: The outer margins of the ventral fins when held at right angles to the tail are only shallowly concave, nearly straight, the fish is a Big Skate (*Raja binoculata*). (See page 51.)

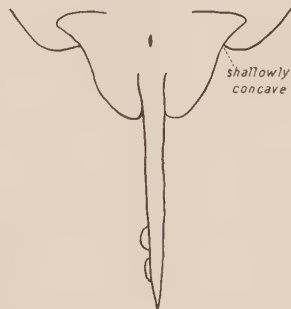


FIG. 18.

* * * *

31. IF: The entire front margin of the disk on each side is deeply concave, the snout tapering to a point, the fish is a Long-nosed Skate (*Raja rhina*). (See page 53.)



FIG. 19.

BUT IF: The entire front margin of the disk on each side is not deeply concave, and the tip of the snout projects only slightly, the fish is a California Skate (*Raja inornata*). (See page 49.)



FIG. 20.

32. IF: The back is plainly colored, without distinct spots the fish is a Rough-tail Skate (*Raja trachura*). (See page 56.)

BUT IF: The back is spotted with darker and lighter shades, see section 33.

* * * *

33. IF: There is a groove with bony sides between and in front of the eyes, the fish is a Monterey Skate (*Raja montereyensis*). (See page 54.)

BUT IF: There is no such groove with bony sides, the top of the snout being entirely soft and fleshy, the fish is a Starry Skate (*Raja stellulata*). (See page 55.)

* * * *

34. IF: The tail is less than $\frac{1}{2}$ the length of the rest of the body, the fish is a Butterfly Sting Ray (*Pteroplatea marmorata*). (See page 60.)

BUT IF: The tail is more than $\frac{1}{2}$ the length of the rest of the body, see section 35.

* * * *

35. IF: The tail is shorter than the rest of the body, the fish is a Round Sting Ray (*Urolophus halleri*). (See page 58.)

BUT IF: The tail is longer than the rest of the body, see section 36.

* * * *

36. IF: There is no well-defined dorsal fin, the fish is a Diamond Sting Ray (*Dasyatis dipterurus*). (See page 59.)

BUT IF: There is a well-defined single dorsal fin, see section 37.

* * * *

37. IF: A pair of projecting arms extends from under the front part of the head, giving the fish a horned appearance, and the tail is much shorter than the width of the body, the fish is a Manta (*Manta birostris*). (See page 62.)

BUT IF: There are no such projecting arms on the head, and the tail is almost as long or longer than the width of the body, the fish is a Bat Sting Ray (*Aetobatus californicus*). (See page 61.)

DESCRIPTIONS AND ILLUSTRATIONS
OF FISHES



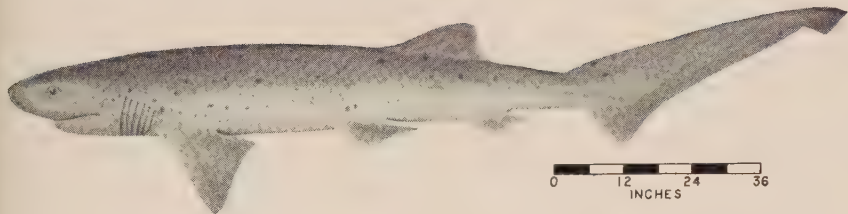


FIG. 21.

From Daniel, 1922.

SEVEN-GILL SHARK

Notorynchus maculatus

Relationship: Belongs to the cow shark family (Hexanchidae), in which is also classed the six-gill shark, which occurs in California.

Distinguishing Characters: The seven gill slits on each side of the body; the single dorsal fin. **Color:** Sandy-gray or brownish, with a few, small, round black spots scattered sparsely over the back and sides. Attains a length of over 15 feet. Viviparous.

Distribution: San Diego northward to Washington; uncommon south of Monterey Bay.

Importance: Of slight commercial value, being rarely seen in San Francisco and other northern California markets. Fishermen very seldom take it because of its usual large size.

Unauthorized names: Cow shark, mud shark.

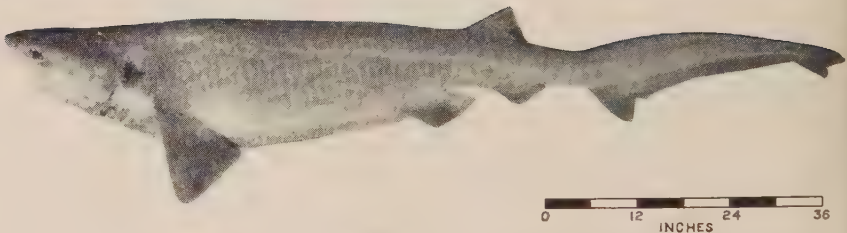


FIG. 22.

Photo by Hawthorne Studios, Los Angeles.

SIX-GILL SHARK

Hexanchus corinus

Relationship: Belongs to the cow shark family (Hexanchidae), in which is classed one other species which occurs in California—the seven-gill shark.

Distinguishing Characters: The six gill slits on each side of the body; the single dorsal fin. **Color:** Dark gray, almost black, a pale streak along the side. Attains a length of over 15 feet. Viviparous.

Distribution: Pacific coast of America; San Diego northward to Puget Sound.

Importance: Seen only rarely in the fish markets of northern California, being taken very infrequently by commercial fishermen, perhaps because of its usual large size.

Unauthorized names: Shovel-nosed shark, cow shark.

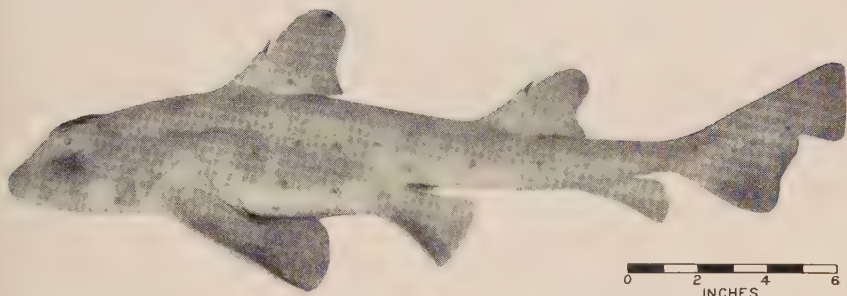


FIG. 23.

Photo by Hawthorne Studios, Los Angeles.

HORNED SHARK

Heterodontus francisci

Relationship: The only member of the Port Jackson shark family (Heterodontidae) which occurs in California. Of interest to palæontologists because of its supposed close relation to extinct forms.

Distinguishing Characters: The presence of an anal fin; the single spine at the front of each dorsal fin. **Color:** Brown, with small black spots scattered over the body and fins. Attains a length of between 2 and 3 feet.

Distribution: Coast of California to Magdalena Bay in Lower California.

Importance: Of slight commercial value, being taken rather infrequently by fishermen, who sell it along with other sharks to reduction plants.

Notes: Deposits eggs, which have a horny covering protected by a double spiral flange. These eggs are often sold as curios. The teeth are especially adapted for eating mollusks, crabs, sea urchins and other hard-shelled animals.

Unauthorized names: Port Jackson shark, bullhead shark.



FIG. 24.

Walford, del.

BROWN SHARK

Scyliorhinus brunneus

Relationship: Belongs to the cat shark family (Scyliorhinidae) in which are also classified two other species that occur in California, the file-tail shark and the swell shark.

Distinguishing Characters: The presence of an anal fin; the front of the first dorsal fin being above or behind, not in front of, the ventral fins; the presence of a fold of skin around each corner of the mouth, the part of the fold on the lower jaw being slightly shorter than that on the upper; the absence of enlarged scales on the upper edge of the tail fin; the absence of dark spots on the body. **Color:** Uniform warm brown above and below, the snout and edges of the fins usually blackish. Attains a length of about 2 feet. Deposits eggs.

Distribution: Gulf of California and northward, in deep water; Monterey Bay; Puget Sound; Hoods Canal.

Importance: Very rarely seen in the markets of California, and very rarely taken by commercial fishermen.

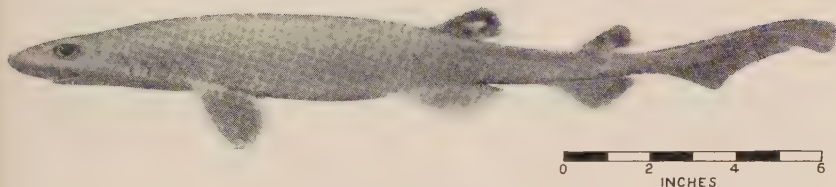


FIG. 25.

From Garman, 1913.

FILE-TAIL SHARK

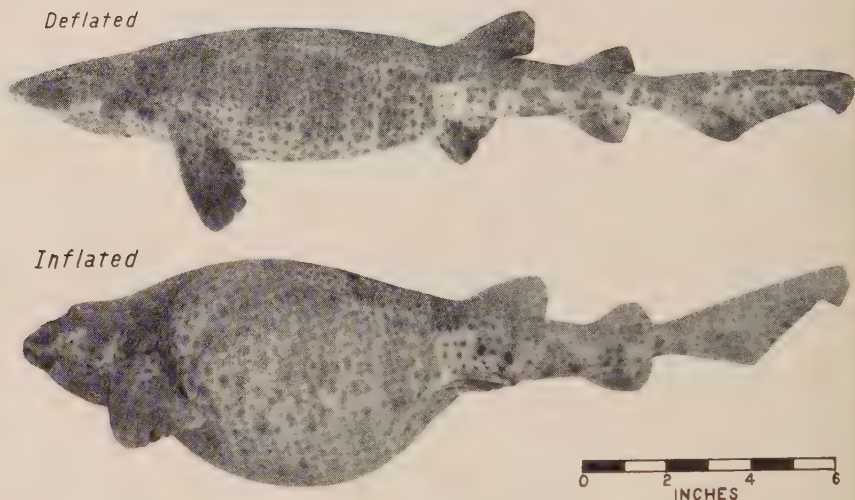
Parmaturus xanthurus

Relationship: Belongs to the cat shark family (Scyliorhinidae), in which are also classified two other species that occur in California, the swell shark and the brown shark.

Distinguishing Characters: The presence of an anal fin; the front of the first dorsal fin being above, not in front of, the ventral fins; the presence of a fold of skin around each corner of the mouth, the part of the fold on the lower jaw being about twice as long as that on the upper jaw; the broad band of enlarged crowded scales on the upper edge of the tail (noticeable only in the adult); the pale belly. **Color:** Dark slaty brown, usually uniform above, sometimes with small whitish spots, the fins often edged with paler; belly pale. Attains a length of about 2 feet. Deposits eggs.

Distribution: Pacific coast of southern and Lower California, south to about Fort San Bartholome.

Importance: Very rarely seen in the markets of California and very rarely taken by fishermen.



Coper photo by Hawthorne Studios, Los Angeles; lower by R. S. Croker.

FIG. 26.

SWELL SHARK

Cephaloscyllium uter

Relationship: Belongs to the cat shark family (Scyliorhinidae), in which are also classified two other species that occur in California, the file-tail shark and the brown shark.

Distinguishing Characters: The presence of an anal fin; the front of the first dorsal fin being above, not in front of, the ventral fins; the absence of a groove around each angle of the mouth; the head from the region of the spiracles forward being broader than long; the thick skin, and the large, rough scales; the presence of dark, irregular spots and bars on the back and sides. **Color:** Various shades of brown, tinged below with yellowish; back and sides with rather indistinct black crossbars and with small round dark and whitish spots. Attains a length of about 3 feet.

Distribution: Monterey to San Diego.

Importance: Very rarely seen in the markets of California, though rather frequently taken by fishermen. It causes some trouble through its habit of entering lobster traps.

Notes: When caught, the swell shark inflates its stomach with air until its diameter is about one-third its whole length. Feeds on other fishes, its large mouth being capable of accommodating fishes of surprisingly large size. Ovoviparous.



FIG. 27.

Photo by Hawthorne Studios, Los Angeles.

GRAY SMOOTH-HOUND

Mustelus californicus

Relationship: Belongs to the family of typical sharks (Galeidae), in which are also classed the leopard, the brown smooth-hound, the soupfin, the tiger, the great blue, and the bay sharks. The other smooth-hound shark, *Rhinotriacis henlei*, is very similar in appearance to this species, and may be recognized by a difference in the teeth. Another closely related species, the southern smooth-hound (*Mustelus lunulatus*) is taken occasionally at San Diego.

Distinguishing Characters: The presence of an anal fin; the first dorsal fin being situated in front of the ventral fins; the absence of a keel on each side of the root of the tail; the teeth being very blunt, flat and pavement-like, without points (when the finger is passed over the teeth from behind forward, no points may be felt); the front of the pectoral fin, when held close to the body, not reaching past the front fourth of the base of the first dorsal fin. **Color:** Back and sides dark gray with a metallic iridescent luster above, and whitish below. Attains a length of about $3\frac{1}{2}$ feet. Oviparous.

Distribution: Cape Mendocino southward into the Gulf of California.

Importance: One of the four most important sharks in the fish markets of California.

Unauthorized names: Mud shark, dogfish, paloma, sand shark, gray shark.



FIG. 28.

Photo by Hawthorne Studios, Los Angeles.

BROWN SMOOTH-HOUND

Rhinotriacis henlei

Relationship: Belongs to the family of typical sharks (Galeidae), in which are also classed the gray smooth-hound, the leopard, the soupfin, the tiger, the great blue, and the bay sharks. The other smooth-hound shark (*Mustelus californicus*) is very similar in appearance to this species, and may be recognized by a difference in the teeth.

Distinguishing Characters: The presence of an anal fin; the first dorsal fin being situated in front of the ventral fins; the absence of a keel on each side of the root of the tail; the teeth being low but with sharp points, which may be felt when the finger is passed over them from behind forward; the teeth occurring in at least 5 rows; the tip of the pectoral fin, when held close to the body, reaching to below the middle of the base of the first dorsal fin. **Color:** Bronze above, sometimes becoming silvery on the sides; white below. Attains a length of over 3 feet. Ovoviparous.

Distribution: Coast of California from Humboldt Bay to San Diego.

Importance: One of the sharks most commonly seen in the fish markets of California.

Unauthorized names: Mud shark, dogfish, paloma, sand shark, Henle's shark.

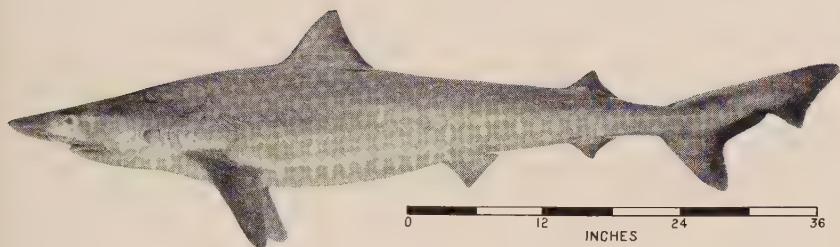


Photo by Hawthorne Studios, Los Angeles.

FIG. 29.

SOUPFIN SHARK

Galeorhinus zyopterus

Relationship: Belongs to the family of typical sharks (Galeidae) in which are also classed the smooth-hounds, the tiger, the great blue, and the bay sharks.

Distinguishing Characters: The presence of an anal fin; the first dorsal fin being situated in front of the ventral fins; the absence of a keel on each side of the root of the tail; the tail fin being shorter than the rest of the body; the head being normally formed; the teeth being sharp and in 2 to 4 rows, those on the side of the jaw being notched on the outer edge below the point, the lower part of the notch being divided into from 2 to 5 points (**note:** one must examine the teeth closely to see the notches). **Color:** Dark gray on the back, often with a purplish tinge, becoming paler below and white underneath. Attains a length of about 6 feet.

Distribution: Coast of California and Lower California, from Humboldt Bay to Cedros Island.

Importance: Probably the most important of the market sharks in California. The Chinese consider the fins of this species to be superior to those of all other California sharks.

Notes: Ovoviparous; as many as 26 young have been taken from a single female. Feeds mostly on fish.

Unauthorized name: Oil shark.

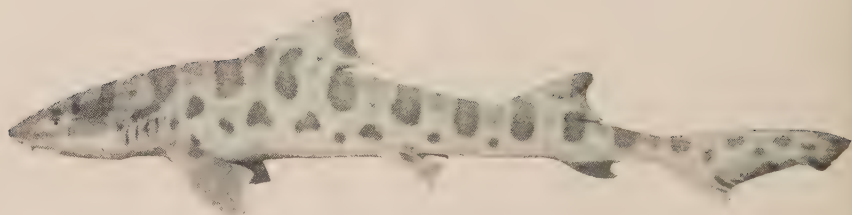


Photo by Hawthorne Studios, Los Angeles.

FIG. 30.

LEOPARD SHARK

Triakis semifasciata

Relationship: Belongs to the family of typical sharks (Galeidae), in which are also classed the smooth-hounds, the tiger, the great blue, the soupfin, and the bay sharks.

Distinguishing Characters: The presence of an anal fin; the first dorsal fin being situated in front of the ventral fins; the smoky black crossbars which extend across the back down to the middle of the side, and the spots which occur on the lower part of the side. **Color:** Gray, overlaid with smoky and with more or less iridescence, with the crossbars and spots as described above; belly pale. Attains a length of 5 feet or more. **Ovoviparous.**

Distribution: San Francisco to Ballenas Bay on the coast of Lower California, in rather shallow water, and in sloughs.

Importance: One of the sharks most commonly seen in the markets of southern California and most commonly taken by anglers. Used almost entirely for food.

Unauthorized name: Cat shark.

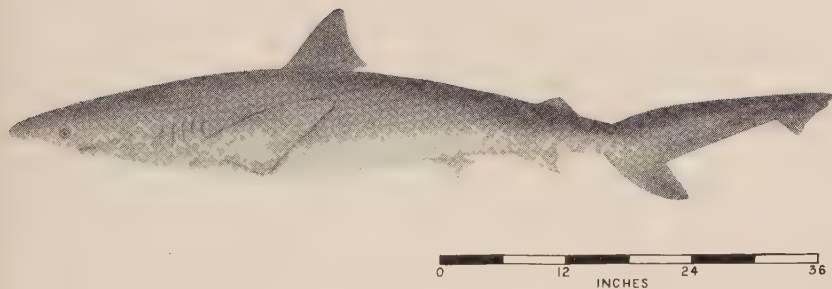


FIG. 31.

Walford, del.

BAY SHARK

Carcharias lamiella

Relationship: Belongs to the family of typical sharks (Galeidae), in which are also classed the smooth-hounds, leopard, great blue, tiger and bay sharks.

Distinguishing Characters: The presence of an anal fin; the absence of spiracles; the first dorsal fin being nearer the base of the pectoral fins than to the base of the ventral fins; the absence of a keel on each side of the root of the tail; the tail fin being shorter than the rest of the body; the head being normally formed. **Color:** Plain gray above becoming white below. Attains a length of between 10 and 15 feet. Ovoviparous.

Distribution: San Pedro southward to Mazatlan, Mexico; rare north of San Diego; common in San Diego Bay.

Importance: Occasionally taken incidentally by San Diego fishermen for a local reduction plant. Used entirely in the manufacture of fertilizer.

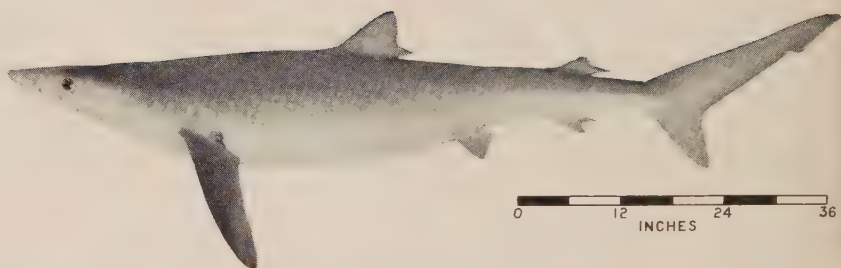


FIG. 32.

Photo by Hawthorne Studios, Los Angeles.

GREAT BLUE SHARK

Prionace glauca

Relationship: Belongs to the family of typical sharks (Galeidae), in which are also classed the smooth-hounds, the tiger, the soupfin, and the bay sharks.

Distinguishing Characters: The presence of an anal fin; the first dorsal fin being situated in front of the ventral fins; the absence of a keel on each side of the root of the tail; the tail fin being shorter than the rest of the body; the head being normally formed; the absence of spiracles; the long, slender pectorals, which reach past the front of the first dorsal; the first dorsal fin being nearer the base of the ventral fins than to the base of the pectoral fins. **Color:** Back and fins indigo blue; lower part of sides and below white. Attains a length of about 15 or 20 feet, but specimens taken in California are usually under 10 feet. Oviparous.

Distribution: Tropical seas throughout the world; occurs on the Pacific coast from Washington southward into the Gulf of California.

Importance: One of the less important of the sharks, being seen in the fish markets only occasionally during the summer.

Unauthorized name: Blue shark.



FIG. 33.

Photo by D. H. Fry, Jr.

TIGER SHARK

Galeocerdo arcticus

Relationship: Belongs to the family of typical sharks (Galeidae) in which are also classed the smooth-hounds, the leopard, the great blue, the soupfin, and the bay sharks. A world-wide species.

Distinguishing Characters: The presence of an anal fin; the first dorsal fin being situated in front of the ventral fins; the absence of a keel on each side of the root of the tail; the tail fin being shorter than the rest of the body; the head being normally formed; the teeth all having saw-toothed edges, as well as a deep notch in their outer margins; the presence of spiracles. **Color:** Brown, with numerous dark irregular spots larger than the eye; adult nearly uniform grayish brown. Is said to attain a length of between 25 and 30 feet. Ovoviparous.

Distribution: Tropical seas, occasionally to Iceland and Cape Cod; once recorded from San Diego.

Importance: So rare in California as to be of negligible local interest.



Photo by Hawthorne Studios, Los Angeles.

FIG. 34.

BONITO SHARK

Isurus glaucus

Relationship: Belongs to the mackerel shark family (Isuridae), in which are also classed the mackerel and the great white sharks. Other members of this group are found distributed throughout the world, particularly in warm seas.

Distinguishing Characters: The keel on each side of the root of the tail; the rather long, fang-like teeth, the edges of which are smooth; the front of the first dorsal fin being behind the root of the pectoral fin. **Color:** Dusky slate-blue above, shading into white on the lower part of the sides and underparts. Attains a length of between 10 and 15 feet.

Distribution: Southern California, Japan and Hawaii.

Importance: One of the most important of the sharks taken for the fresh fish markets of San Pedro. Used almost entirely for food.

Unauthorized names: Mackerel shark, spriglio, paloma.



FIG. 35.

Walford, del.

MACKEREL SHARK

Lamna cornubica

Relationship: Belongs to the mackerel shark family (Isuridae), in which are also classed the bonito shark and the great white shark, which occur in California, as well as several other species which are found in other parts of the world. It is possible that this species does not occur in California and has been confused with the bonito shark by observers.

Distinguishing Characters: The keel on each side of the root of the tail; the rather long, fang-like teeth, the edges of which are smooth, the bases of which each have a small projection; the front of the first dorsal fin being above the end of the root of the pectoral fin. **Color:** Bluish-black above, growing rather abruptly white at the middle of the sides. Attains a length of at least 10 feet. Ovoviparous.

Distribution: Recorded (possibly erroneously) in north Pacific Ocean from Alaska and California; north Atlantic Ocean.

Importance: Of slight importance commercially in California if it is taken at all.

Unauthorized names: Porbeagle, salmon shark.



FIG. 36.

From Garman, 1913.

GREAT WHITE SHARK

Carcharodon carcharias

Relationship: Belongs to the mackerel shark family (Isuridae), in which are also classed the bonito shark and the mackerel shark of California, as well as several other species which are found throughout the world.

Distinguishing Characters: The keel on each side of the root of the tail; the large triangular teeth, both edges of which are serrate (saw-toothed). **Color:** Lead-gray on the back and sides; white below; tips and edges of pectorals black. Said to reach a length of over 40 feet. Specimens from California have measured as high as 30 feet.

Distribution: Temperate and tropical parts of the Pacific and Atlantic; on the American coasts north to Monterey and New York. Apparently not common in California.

Importance: Of negligible commercial importance in California, being very seldom taken by fishermen, and mostly from San Diego southward.

Notes: Considered the strongest and most voracious of all sharks, most accounts of attacks on man being referred to this species. Reliable people in various parts of the world have reported finding in the stomachs of specimens a 100-pound sea lion (California), a large Newfoundland dog (Australia), a whole horse (Australia). Ordinarily it feeds on large fish and other marine vertebrates. Nothing is known of its breeding habits.

Unauthorized name: Man-eater shark.

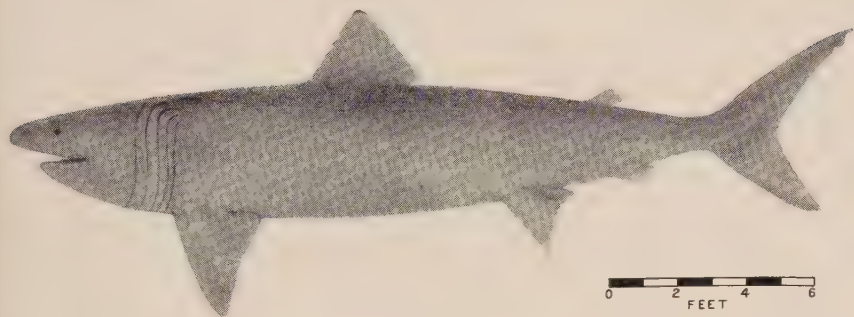


FIG. 37.

Walford, del.

BASKING SHARK

Cetorhinus maximus

Relationship: The only existing species of the basking shark family (Cetorhinidae) known in the world. Derives its name from a habit of drifting slowly along the surface of the water as if basking in the sun.

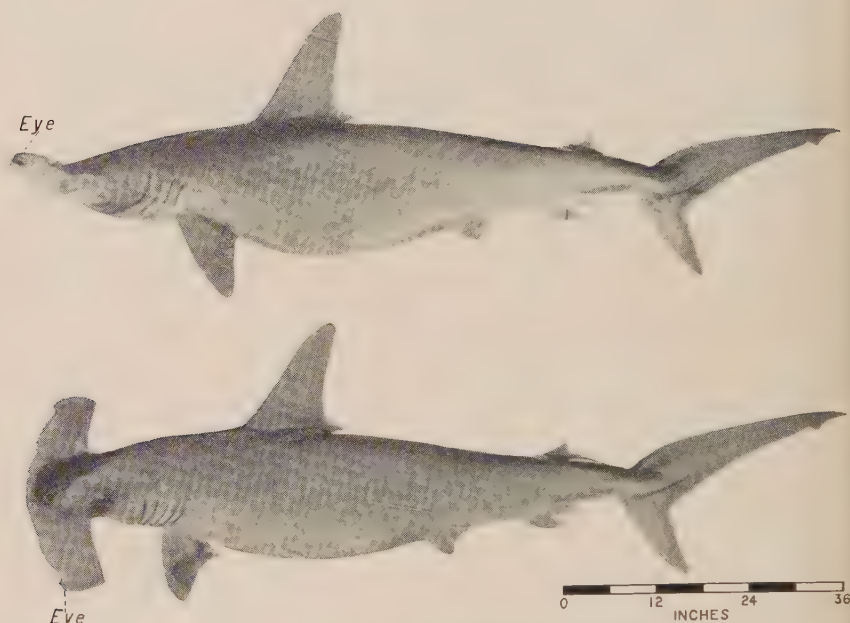
Distinguishing Characters: The exceedingly long gill slits, which extend from the back to nearly the mid-line of the throat, almost meeting under the throat; the teeth being small, very numerous, smooth-edged and rather conical in shape. **Color:** Back leaden gray; lower surface white. Attains a length of at least 45 feet. The largest specimen recorded from Monterey was a few inches under 30 feet and weighed 8600 pounds; the liver, 60 per cent of which was oil, weighed over 2100.

Distribution: Found all over the world in northern and southern seas. In California occurs as far south as San Diego, but rarely south of San Simeon Bay.

Importance: Because of the enormous size of this fish, and the difficulty in handling, the basking shark is not exploited as much as it could be. Ordinary fishing boats are too small, whalers too large to handle these fish profitably; consequently, basking shark fishing is merely a side line of pleasure excursion boats. Used in the manufacture of fertilizer and chicken feed, the oil from the liver also being extracted for medicinal and industrial purposes. The flesh is claimed by some people to be of superb quality.

Notes: Occurs during the winter months between November and February, mostly in Monterey and San Simeon Bays. Sometimes appears in schools of 20 or 30 individuals, swimming close to the surface of the water, the high dorsal fins protruding above. Like most whales, the basking shark feeds exclusively on minute marine organisms. Fishermen take this fish by harpooning it underneath the pectoral fin. Immediately after being harpooned, the fish goes to the bottom and rolls around, attempting to extricate the harpoon, and often succeeding. Finally, it rises to the surface, is lashed to the side of the boat with chains, and brought to shore. Nothing is known of the breeding habits. Is said to have been once plentiful off the New England coast and off the Norwegian coast, but in these regions it has evidently been depleted.

Unauthorized names: Elephant shark, bone shark, sailfish, sunfish, pelerin, hoe-mother, capidoli, oilfish, oil shark.



Photos by Hawthorne Studios, Los Angeles.

FIG. 38.

HAMMERHEAD SHARK

Sphyrna zygaena

Relationship: The only member of the hammerhead shark family (Sphyrnidae) which occurs in California.

Distinguishing Characters: The peculiar formation of the head, which is mallet-shaped, the eyes being on the ends of the "mallet." **Color:** Plain dark slate gray above, shading into paler below. Attains a length of about 15 feet.

Distribution: Occurs in the Pacific from the Channel Islands southward; Mazatlan, Bay of Panama, and Japan; in the Atlantic from Cape Cod southward.

Importance: Rarely seen in the California markets. Fishermen report frequently taking these fish and wastefully throwing them back after killing or maiming them. Specimens are landed occasionally in San Diego for the reduction plant.

Notes: Frequents the open sea, often swimming with dorsal and tail fins above the surface. Feeds mostly on smaller fish, squids and crustacea. Young specimens are never seen in California, and it is probable that birth takes place farther south. The hammerhead is ovoviparous, as many as 37 embryos having been taken from a female 11 feet long, which was captured on the Atlantic coast.

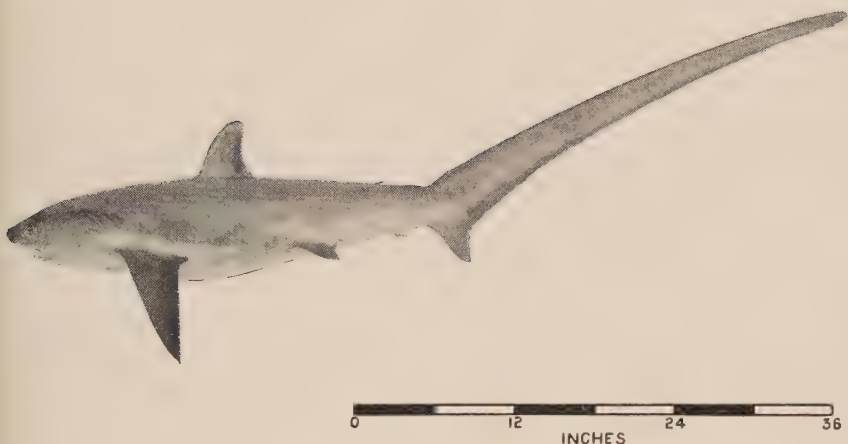


FIG. 39.

Photo by Hawthorne Studios, Los Angeles.

THRESHER

Alopias vulpes

Relationship: Is in a family by itself, the Alopiidae, of which this species is said to be the only existing member.

Distinguishing Characters: The great length of the upper lobe of the tail fin, which is about as long as the rest of the body. **Color:** Purplish or bluish gray with a metallic luster above, becoming paler on the sides and white on the under parts; fins purplish or bluish gray. Attains a total length of over 20 feet.

Distribution: Widely distributed throughout the world. Has been recorded on our coast as far north as Coos Bay, Oregon, and is said to extend at least as far south as the Isthmus of Panama. Very common in the fish markets of San Pedro.

Importance: One of the sharks most commonly seen in the fresh fish markets of southern California. Of high reputation as a game fish.

Notes: Stories that the thresher shark is an enemy of whales are generally considered false. The teeth are so weak that it would be impossible for a thresher to attack a whale successfully. Feeds on small schooling fish; is said to use its tail as a scarer to herd the fish together.

Unauthorized name: Long-tail shark.

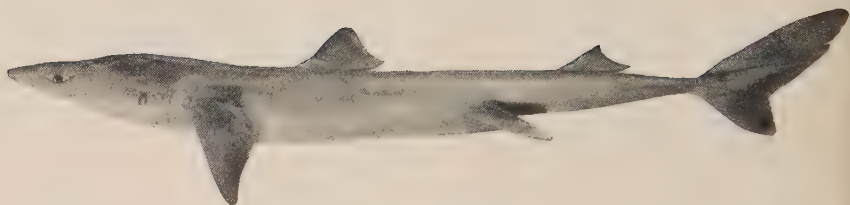


FIG. 40.

Photo by Lauck, San Francisco.

GRAYFISH

Squalus suckleyi

Relationship: Is the only member of the dogfish family (Squalidae) which occurs in California. Closely related to the dogfish of the Atlantic coast, of the south Pacific Ocean, and of the Indian Ocean.

Distinguishing Characters: The absence of an anal fin; the spine in the fore part of each dorsal fin. **Color:** Slaty gray, shading into white on the lower parts; white spots often scattered over body, especially in the young. Attains a length of about 4 feet.

Distribution: San Diego northward to the Aleutian Islands.

Importance: The commonest shark seen in the markets of central and northern California. Rather small amounts are used for food, the bulk of the catch being manufactured into fertilizer.

Notes: Is said to use the spines for defense, curling like a bow and striking. Schools near rockfish banks, and is considered a pest by fishermen, for it is destructive to nets as well as to fish. Feeds voraciously on other fish. Is ovoviparous.

Unauthorized names: Dogfish, dog shark.

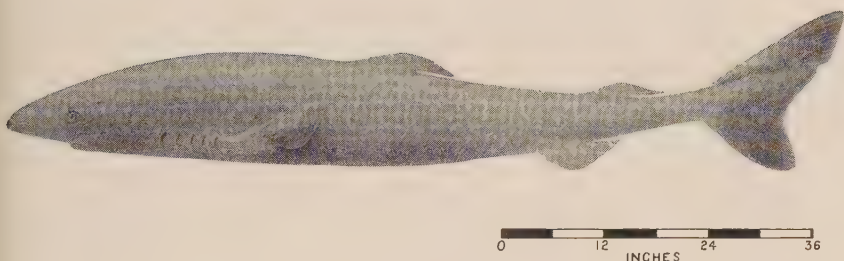


FIG. 41.

From Garman, 1913.

SLEEPER SHARK

Somniosus microcephalus

Relationship: Belongs to the sleeper shark family (Somniosidae),* in which is sometimes classed one other species.

Distinguishing Characters: The absence of an anal fin; the absence of spines in the dorsal fins; the short pectoral fins, which are well separated from the ventrals.

Color: Black, or blackish brown. Attains a length of at least 8 feet.

Distribution: Southern California northward to Alaska; Japan.

Importance: Of slight commercial importance, being taken by California fishermen very rarely.

Notes: Is one of the most sluggish of sharks, lying in muddy or clay bottoms, and coming to the surface apparently only to eat. Feeds largely on carrion, but also on live fish. The belief that this shark attacks live whales is probably erroneous. Offers no resistance when hooked. Ovoviparous.

Unauthorized name: Nurse shark.

* Some writers place these fish in the same family as the grayfish (Squalidae).

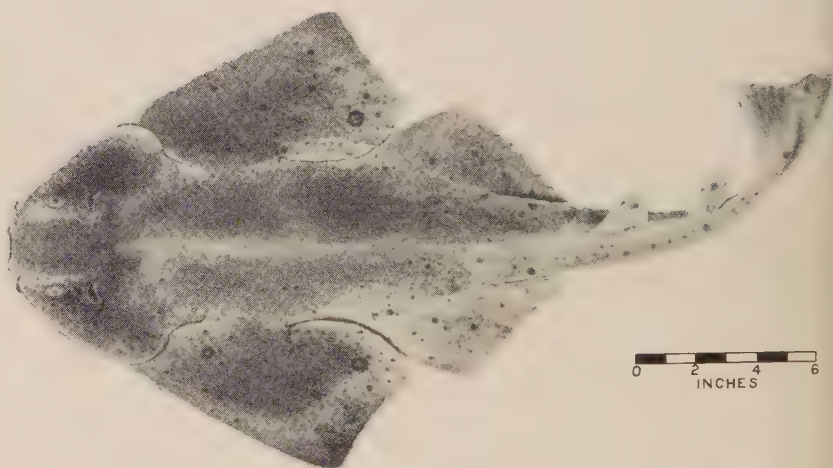


FIG. 42.

From Garman, 1913.

ANGEL SHARK

Squatina californica

Relationship: Is the only species of the angel shark family (Squatinidae) which occurs in California. In appearance and structure, this fish is intermediate in relationship between the sharks and the rays.

Distinguishing Characters: The absence of an anal fin; the gill openings being crowded in a deep notch behind the head; the very large pectoral and ventral fins which give to the body a disk-like or ray-like appearance. **Color:** Dark brownish or ashy, almost black, or reddish brown above; white below; the fins edged posteriorly with gray. Attains a length of between 2 and 3 feet.

Distribution: From southeastern Alaska southward to southern California.

Importance: Of slight if any commercial significance, being infrequently taken by commercial fishermen. Not sold for food.

Notes: Deposits eggs which have a horny covering protected by a double spiral flange. The teeth are especially adapted for eating mollusks, crabs, sea urchins and other hard-shelled animals.

Unauthorized name: Monkfish.

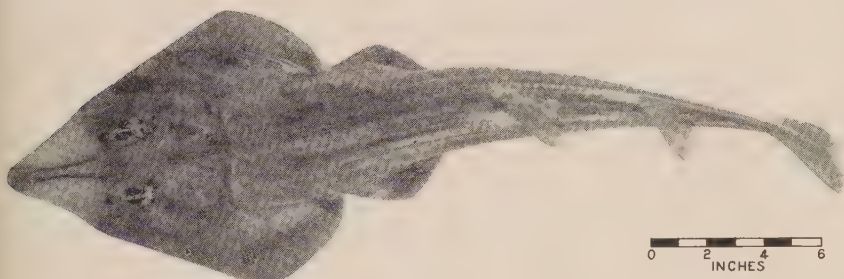


FIG. 43.

Photo by Hawthorne Studios, Los Angeles.

POINTED-NOSED GUITAR FISH

Rhinochimaera pacifica

Relationship: Belongs to the guitar fish family (Rhinochimaeridae), in which are classed two other species that occur on our coast, the striped guitar fish and the thornback, as well as several other species that are found in other parts of the world. Often mistaken by fishermen for the sting ray or stingaree. (See p. 58.)

Distinguishing Characters: The presence of 2 dorsal fins; the presence of a tail fin; the skin being smooth, covered with shagreen (instead of prickles); the spines along the middle of the back and tail, on the shoulder and sometimes around the eye; the pointed, acute snout. **Color:** Back brownish gray, the disk and side of tail more or less edged with buff; undersurface pale. Attains a length of over 4 feet. Ovoviparous.

Distribution: San Francisco to Agua Verde Bay on the coast of Lower California.

Importance: Of slight, if any, commercial significance. Taken in San Diego and sold to the local reduction plant. The commonest of the 3 guitar fishes of California. Often taken by sport fishermen, who wastefully permit them to die, usually in the belief that they are sting rays.

Unauthorized name: Shovel-nosed shark.

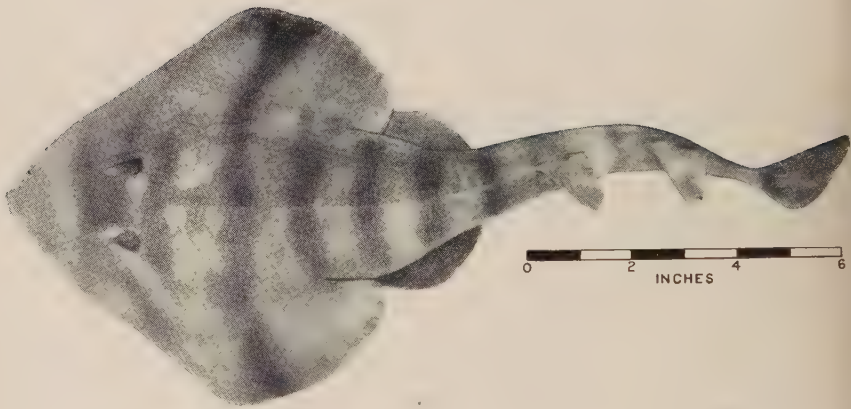


FIG. 44.

Walford, del.

STRIPED GUITAR FISH

Zapteryx exasperata

Relationship: Belongs to the guitar fish family (Rhinobatidae), in which are classed two other species that occur on our coast, the pointed-nosed guitar fish and the thornback, as well as several species that are found in other parts of the world.

Distinguishing Characters: The presence of 2 dorsal fins; the front of the first dorsal fin being situated in front of the middle of the tail; the presence of a tail fin; the back being everywhere covered with irregular scattered tubercles and prickles instead of shagreen; the blunt rounded snout, which does not taper to a point as in the pointed-nosed guitar fish; the low blunt spines on the mid-line of the back and tail, near the eye and at the region of the shoulders. **Color:** Grayish or olive brown, with more or less definite and irregular cross bands of brown across the snout, in front of and between the eyes, and across the back and tail; undersurface pale, a large black blotch at the hind part of the pectoral fin. Attains a length of about 3 feet.

Distribution: San Diego Bay.

Importance: Of slight, if any, commercial significance; used entirely for manufacturing fertilizer. Less commonly taken than the pointed-nosed guitar fish.

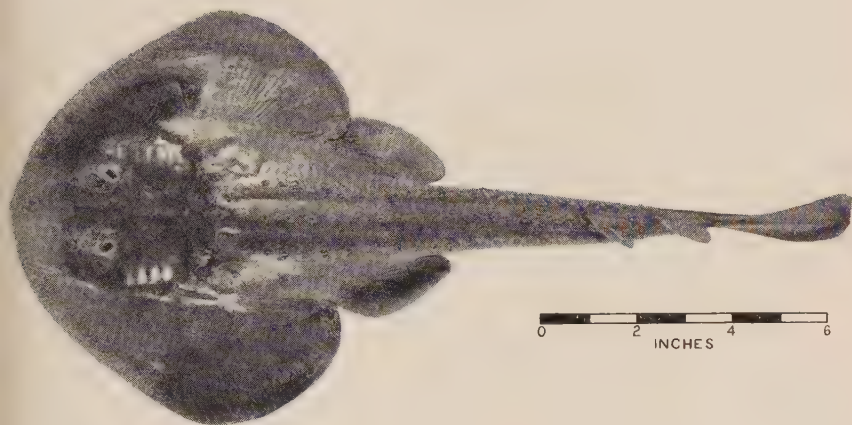


Photo by Hawthorne Studios, Los Angeles.

FIG. 45.

THORNBACK

Platyrrhinoidis triseriatus

Relationship: Belongs to the guitar fish family (Rhinobatidae), in which are also classed the pointed-nosed and the striped guitar fishes.

Distinguishing Characters: The presence of 2 dorsal fins; the first dorsal fin occurring at about the middle of the tail; the obtuse, broadly rounded snout; the skin being covered with fine shagreen; there being strong spines along the middle of the back in usually 3 rows, 2 pairs on each shoulder, and several smaller spines and prickles along the front margin of the pectoral fin. **Color:** Back brownish olive, the disk sometimes edged narrowly with buff; undersurface whitish or buff. Attains a length of between 2 and 3 feet. Ovoviparous.

Distribution: Coast of California, from Point Conception southward.

Importance: Of slight, if any, commercial significance. Used entirely for manufacturing fertilizer.

Unauthorized name: Round skate.



FIG. 46. California Skate. Photos by Hawthorne Studios, Los Angeles.

CALIFORNIA SKATE

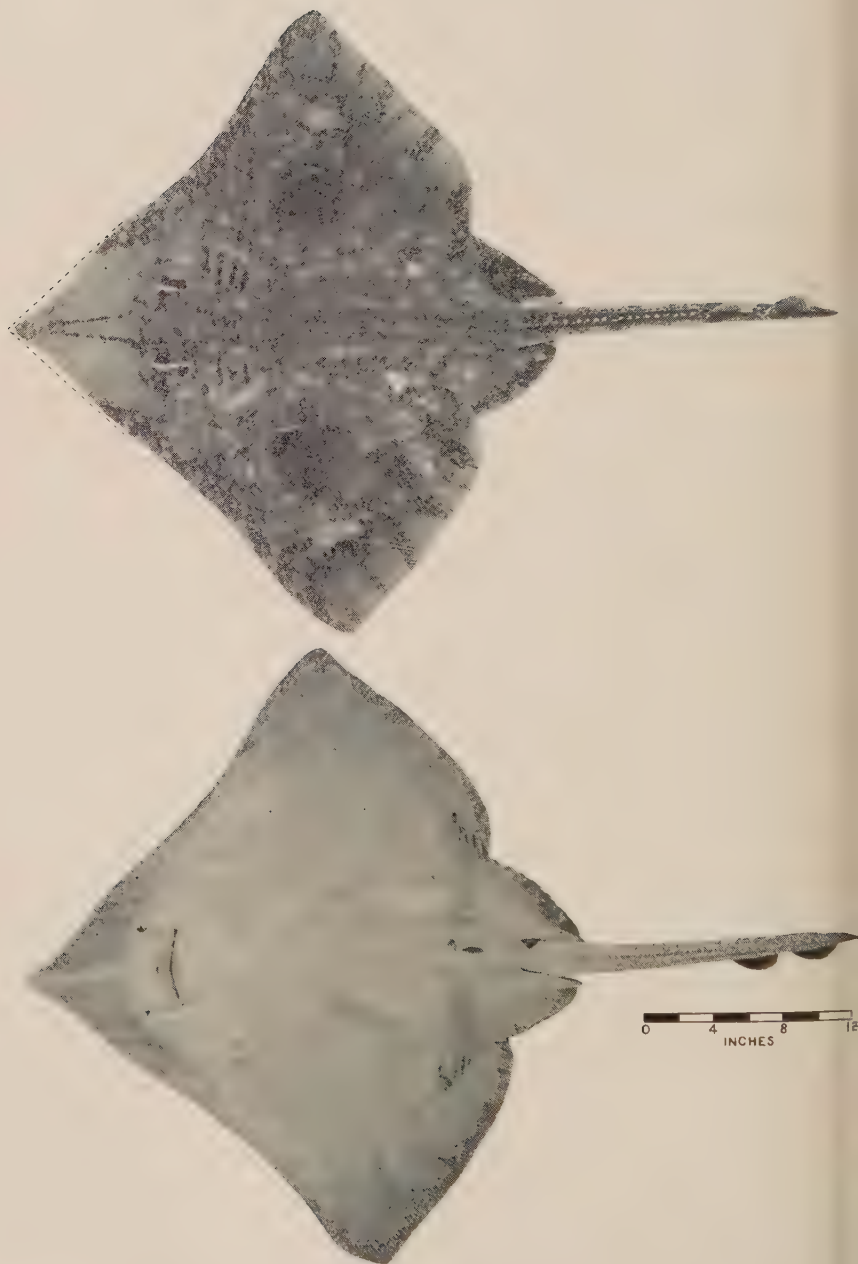
Raja inornata

Relationship: Belongs to the skate family (Rajidae), in which are also classed the long-nosed, the big, the starry, the Monterey and the rough-tail skates, all of which occur in California.

Distinguishing Characters: The presence of 2 dorsal fins; the absence of a distinct tail fin; the outer margin of the ventral fins, when held at right angles to the tail, being deeply concave; lines drawn along the front margin of the disk meeting at slightly more than a right angle. **Color:** Dark olive brown, with usually a small dark ring at the base of each pectoral, and sometimes with two other pale spots on the pectorals; undersurface pale. Attains a length of about $2\frac{1}{2}$ feet. Deposits eggs.

Distribution: San Diego northward to the Straits of Juan de Fuca.

Importance: The most important of the skates in the fresh fish markets of California.



Photos by Hawthorne Studios, Los Angeles.
FIG. 47. Big Skate.

BIG SKATE

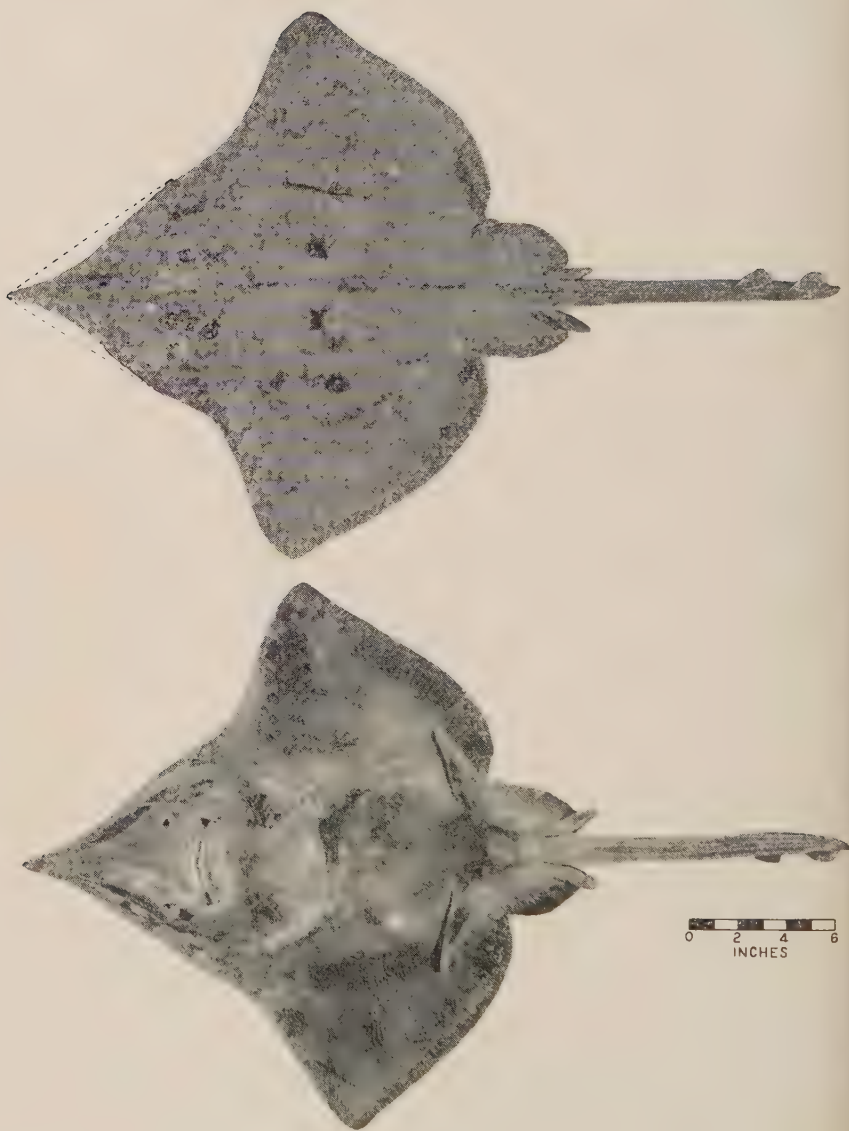
Raja binoculata

Relationship: Belongs to the skate family (Rajidae), in which are also classed the long-nosed, the California, the starry, the Monterey, and the rough-tail skates, all of which occur in California.

Distinguishing Characters: The presence of 2 dorsal fins; the absence of a tail fin; the outer margin of the ventral fins, when held at right angles to the tail, being only shallowly concave; lines drawn along the front margin of the disk meeting at slightly less than a right angle. **Color:** Warm brown or drab, with usually a large dark spot surrounded by a ring of light spots at the base of each pectoral fin; light spots about as large as the eye are scattered over the body. Attains a length of over 6 feet. Deposits eggs.

Distribution: Southern California northward to Alaska. Not common south of Pismo.

Importance: Commercially not taken in large quantities, although it probably forms a fair proportion of the skate catch. Sold entirely in the markets.



Photos by Hawthorne Studies, Los Angeles.
FIG. 48. Long-nosed Skate.

LONG-NOSED SKATE

Raja rhina

Relationship: Belongs to the skate family (Rajidae), in which are also classed the big, the California, the starry, the Monterey, and the rough-tail skates, all of which occur in California.

Distinguishing Characters: The presence of 2 dorsal fins; the absence of a tail fin; the pointed, rather tapering snout, the tip of which is an acute angle; lines drawn along the front margin of the disk meeting at much less than a right angle; the outer margin of the ventral fins, when held at right angles to the tail, being deeply concave. **Color:** Back dark sienna brown with a more or less distinct dark ring at the base of each pectoral, and sometimes with irregular dark spots and blotches; undersurface white. Attains a length of between 3 and 4 feet.

Distribution: Gulf of California to Alaska.

Importance: One of the most important of the skates in California, being frequently seen in the fish markets.

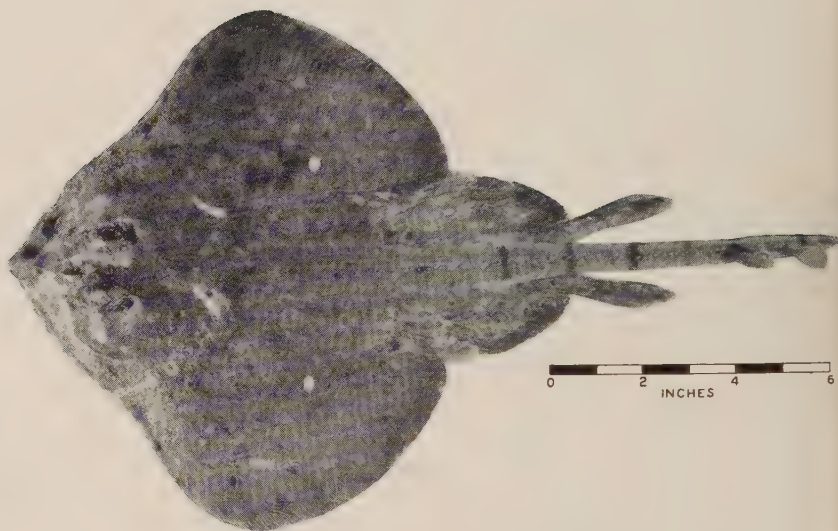


FIG. 49.

Photo by Hawthorne Studios, Los Angeles.

MONTEREY SKATE

Raja montereyensis

Relationship: Belongs to the skate family (Rajidae), in which are also classed the long-nosed, the big, the California, the starry, and the rough-tail skates, all of which occur in California.

Distinguishing Characters: The presence of 2 dorsal fins; the absence of a conspicuous tail fin; the rather blunt snout, lines drawn along the anterior margin of the disk forming an obtuse angle; the back being everywhere covered with prickles, which are coarsest and most numerous on the middle of the back and between the eyes; the presence of a shallow groove with bony sides (rostral ridges) between and in front of the eyes extending forward. **Color:** Back various shades of brown, everywhere more or less distinctly mottled and spotted with dark brown, and with a dark spot surrounded with a ring of small dark irregular spots at the base of each pectoral; this spot is followed by a smaller pale or white spot. Attains a length of between $1\frac{1}{2}$ and 2 feet. Deposits eggs.

Distribution: Santa Cruz to La Jolla.

Importance: Taken by commercial fishermen infrequently, though considered one of the best of the skates.

Unauthorized name: Rock skate.

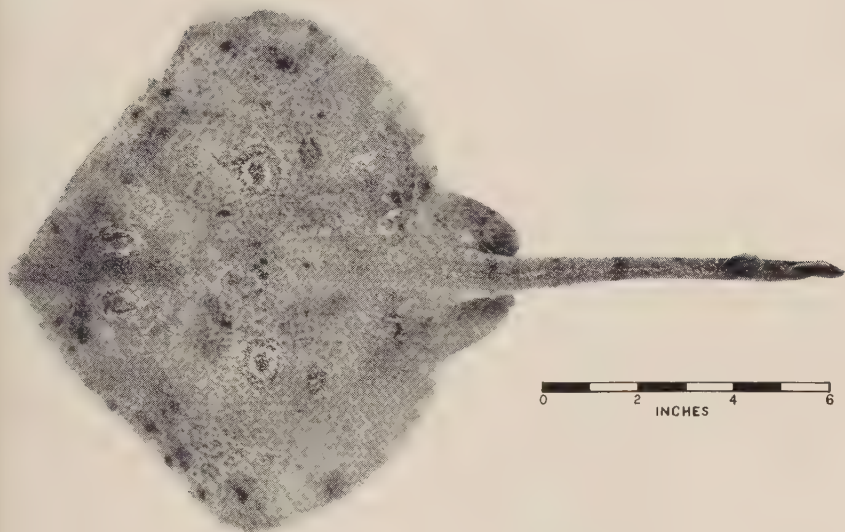


FIG. 50.

Photo by Hawthorne Studios, Los Angeles.

STARRY SKATE

Raja stellulata

Relationship: Belongs to the skate family (Rajidae), in which are also classed the Monterey, the long-nosed, the big, the California, the starry, and the rough-tail skates, all of which occur in California.

Distinguishing Characters: The presence of 2 dorsal fins; the absence of a well-defined tail fin; the rather blunt snout, lines drawn along the anterior margin of the disk forming an obtuse angle; the back being everywhere rough with small prickles; the absence of a groove with bony sides extending forward in front of the eyes, that region being fleshy and soft. **Color:** Grayish brown with small dark spots scattered over the back and with a large irregular yellow spot ringed with brown often at the base of each pectoral and a smaller round one back of it. Attains a length of about $2\frac{1}{2}$ feet, including the tail.

Distribution: Southern California northward to Unalaska.

Importance: Taken by commercial fishermen rather infrequently, though considered one of the best of the skates.

Unauthorized name: Prickly skate.

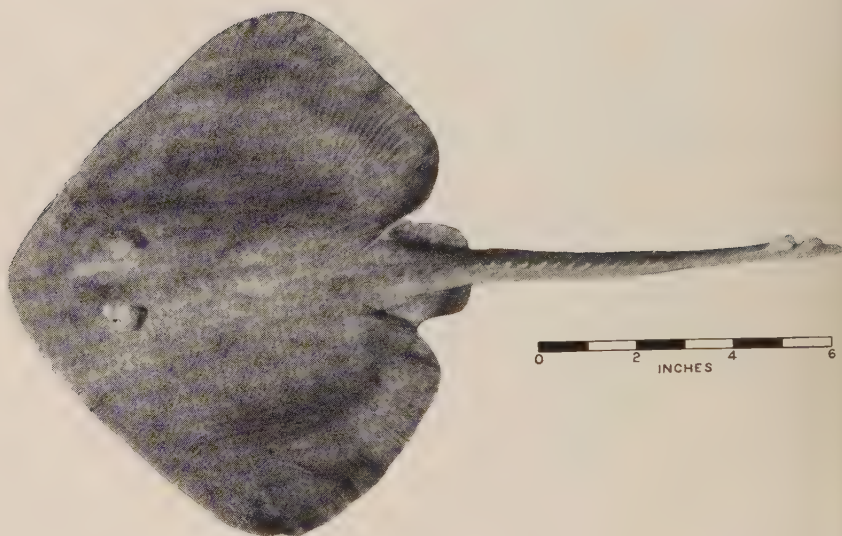


FIG. 51.

Walford, del.

ROUGH-TAIL SKATE

Raja trachura

Relationship: Belongs to the skate family (Rajidae), in which are also classed the big, the California, the long-nosed, the Monterey and the starry skates, all of which occur in California.

Distinguishing Characters: The presence of 2 dorsal fins; the absence of a tail fin; the blunt snout, which forms an obtuse angle; the back being everywhere rough with small sharp prickles; the absence of enlarged spines on the shoulders or near the eyes; the presence of spines down the middle of the back and tail. **Color:** Back plum color, or lead color, darker at the margin; brownish below, becoming dark on the fins. Attains a length of about 18 inches. Deposits eggs.

Distribution: Santa Barbara Islands; off central Alaska. Taken so far only in deep water.

Importance: Of no commercial interest, having been taken very rarely.

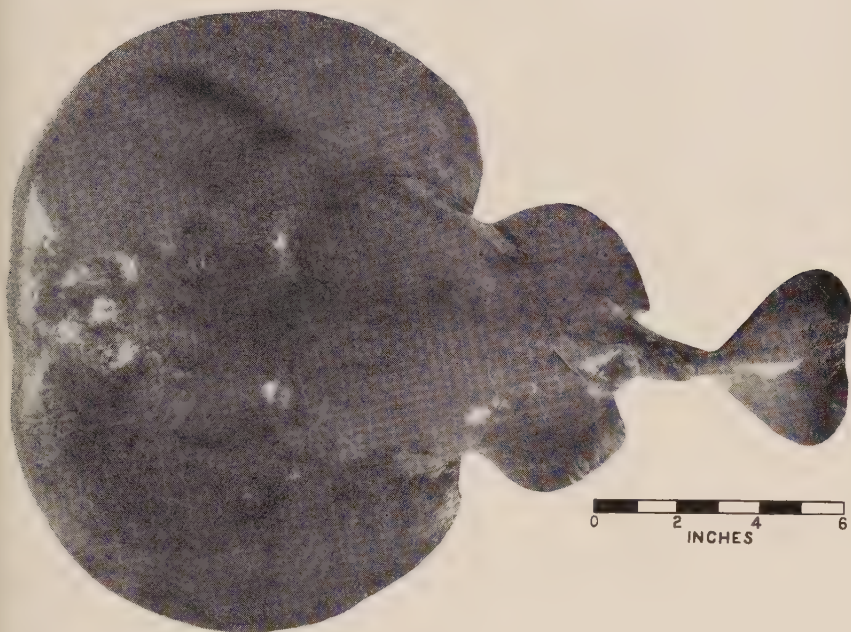


FIG. 52.

Photo by Lauck, San Francisco.

ELECTRIC RAY

Tetronarce californica

Relationship: Is the only representative of the torpedo fish family (Torpedinidae), which occurs in California.

Distinguishing Characters: The presence of 2 dorsal fins; the broad, circular disk, which is covered with smooth skin; the absence of spines or prickles. **Color:** Black blue black, or dark lead color; lower parts white, edged with dark gray. Said to attain a length of 3 feet, but is seldom seen over 2 feet.

Distribution: Cape Flattery, Washington, south to San Pedro.

Importance: Seen very rarely in the markets of California. Taken occasionally by drag nets.

Notes: Electric organs situated at each side of the head and gill chambers, when stimulated, discharge electric shocks of considerable force. Is a bottom-living fish. Oviparous.

Unauthorized names: Torpedo fish, California torpedo, crampfish.

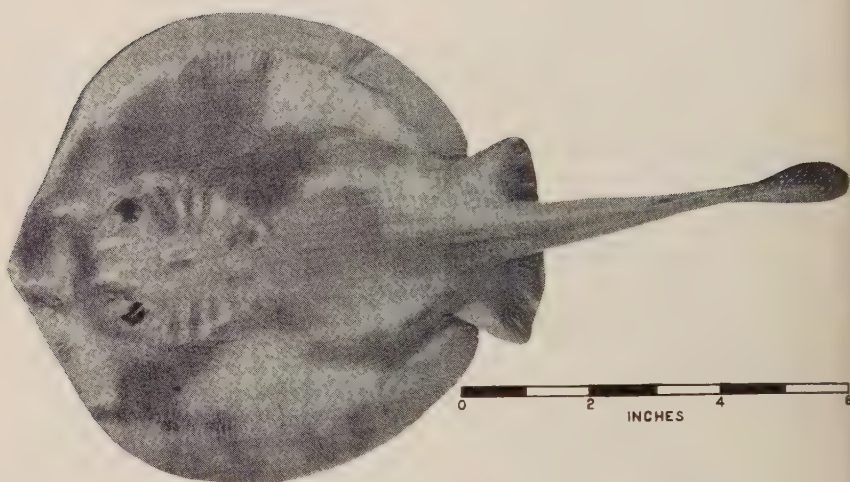


Photo by D. H. Fry, Jr.

FIG. 53.

ROUND STING RAY

Urolophus halleri

Relationship: Belongs to the sting ray family (Dasyatidae), in which are also classed the butterfly and the diamond sting rays, as well as many species which are found in other parts of the world.

Distinguishing Characters: The absence of dorsal fins; the almost circular disk; the tail being slightly shorter than the disk; the long spine or sting on top of the tail. **Color:** Dark brown or slaty brown above, with more or less distinct spots or blotches; undersurface pale. Attains a length of about 20 inches.

Distribution: Point Conception to Panama Bay.

Importance: Taken commercially in small quantities, mostly at San Diego, where it is used in the reduction plant. Not sold in the markets.

Notes: This species lives on the bottom in shallow water, in the surf of beaches and in sloughs, and is probably the most numerous of the California sting rays, consequently the most dangerous to swimmers. Starks (1918) says, "Should a person be so unfortunate as to be stung by one of these rays, he will appreciate the advice to hold the wounded part in hot water * * * and continue (this treatment) * * * even for several hours." Ovoviparous.

Unauthorized name: Stingaree.



FIG. 54.

From Garman, 1913.

DIAMOND STING RAY

Dasyatis dipterurus

Relationship: Belongs to the sting ray family (Dasyatidae), in which are also classed the butterfly and the round sting rays, as well as many species which are found in other parts of the world.

Distinguishing Characters: The absence of definite dorsal fins; the rather diamond-shaped disk; the slender, whip-like tail, which is longer than the disk; the long spine or sting on top of the tail. **Color:** Bluish brown without contrasting color marks. Attains a length of at least 6 feet.

Distribution: Bay of San Diego and southward into the Gulf of California.

Importance: Of slight, if any, commercial significance. Taken occasionally by San Diego fishermen and sold to the local reduction plant.

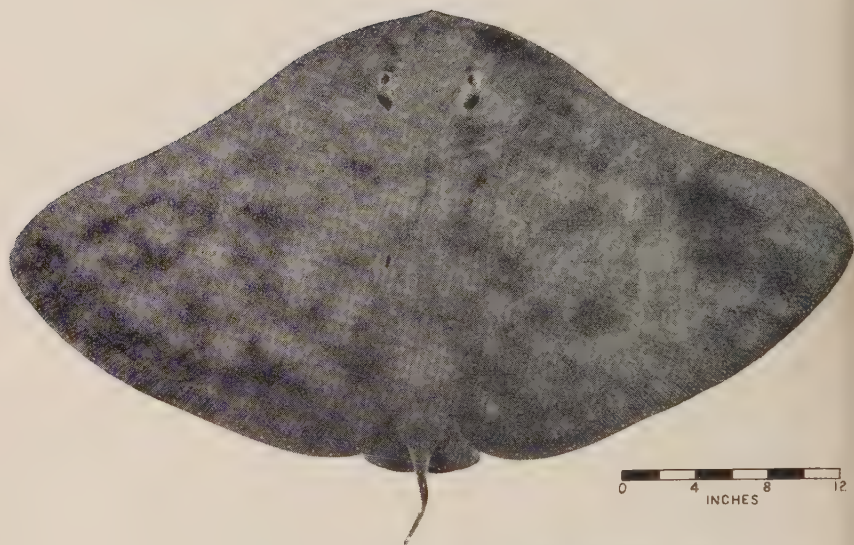


FIG. 55.

Photo by Hawthorne Studios, Los Angeles.

BUTTERFLY STING RAY

Pteroplatea marmorata

Relationship: Belongs to the sting ray family (Dasybatidae), in which are also classed the diamond and the round sting rays.

Distinguishing Characters: The somewhat diamond-shaped disk, which is almost twice as wide as long; the very short tail, which is less than one-third the length of the disk; the small spine or sting on the top of the tail. **Color:** Back brownish or grayish olive of various shades, with many small, more or less distinct dark spots which are often arranged in a definite pattern; back often with white spots. Undersurface white, the disk bordered more or less with buff. Attains a width of between 4 and 5 feet. Ovoviparous.

Distribution: Point Conception southward to Port San Bartholome on the coast of Lower California.

Importance: Of slight, if any, commercial significance, being very rarely seen in the markets.

Unauthorized name: Stingaree.



FIG. 56.

Photo by Hawthorne Studios, Los Angeles.

BAT STING RAY

Aetobatus californicus

Relationship: The only representative of the eagle ray family (Myliobatidae), which occurs on the coast of California.

Distinguishing Characters: The single dorsal fin situated just in front of the sting; the long spine or sting on the back of the tail; the long, whip-like tail, which is almost as long or longer than the width of the body, the head standing above the disk, with the eyes placed on the side of the head close to the edge of the disk. **Color:** Back entirely dark olive color, without contrasting marks; undersurface white, edged with dark gray. Attains a weight of over 150 pounds.

Distribution: Cape Mendocino southward to Santa Maria Bay on the coast of Lower California, in shallow water, sloughs and mud flats.

Importance: Taken commercially only occasionally. Alleged to be very destructive to oyster beds and crabs, and therefore is the object of special exterminating parties by sport fishermen, mostly in the San Francisco Bay region.

Notes: Swims along the bottom until it meets the currents of water expelled by the siphons of clams. It then flaps its pectoral fins, creating a suction which digs out the clams. Sometimes it flaps along in this manner for considerable distances, leaving behind a barren trough.

Unauthorized names: Eagle ray, California sting ray, stingaree.

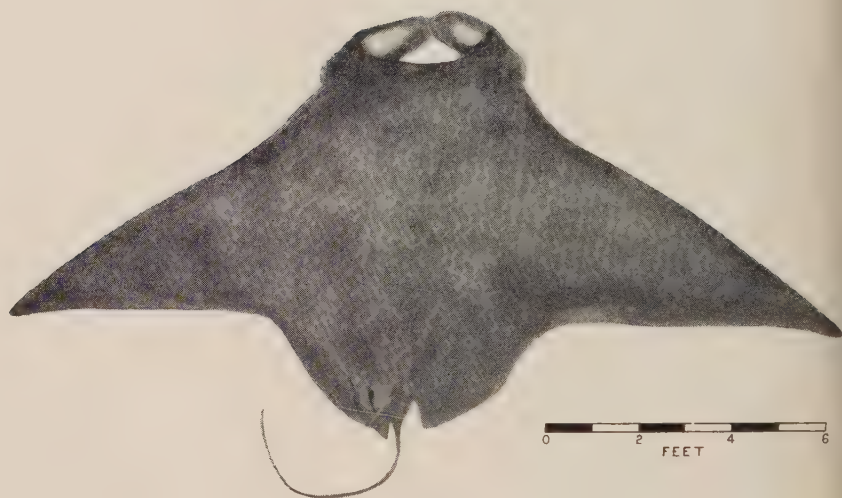


FIG. 57.

Photo by D. H. Fry, Jr.

MANTA

Manta birostris

Relationship: Belongs to the sea-devil family (Mobulidae).

Distinguishing Characters: The single dorsal fin; the pair of projecting arms which extend from the front of the head; the rather long, whip-like tail, which is shorter than the body. **Color:** Dull black above; white below; the back sometimes with dirty white patches caused by abrasions. Attains a width of about 25 feet.

Distribution: Tropical waters of America; north to Redondo on the California coast, and to New Jersey on the Atlantic.

Importance: Rarely taken by fishermen in California.

Notes: In feeding, the manta moves through schools of small fish, turning slowly from side to side, using the fleshy projections of the head almost like hands, to fan the fish into the mouth, and is often observed to leap clear out of the water for a height of several feet. Is viviparous, the young being over 3 feet wide when born.

Unauthorized names: Devilfish, sea-devil, blanketfish.

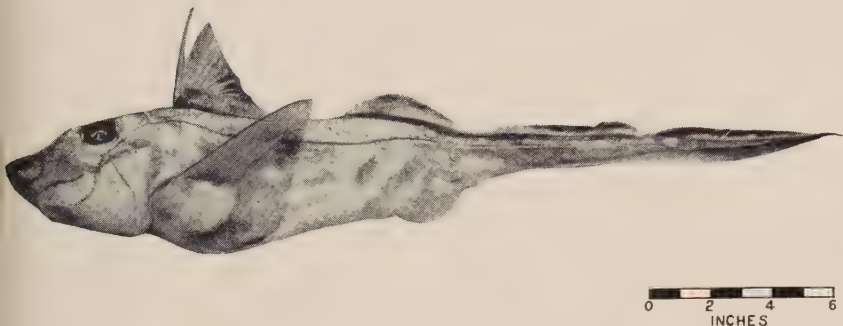


Photo by Swanlund Studio, Eureka.

FIG. 58.

RATFISH

Hydrolagus collieri

Relationship: Belongs to the chimaera family (Chimaeridae), which is separated from the sharks and rays on the one hand, and bony fishes on the other, as a distinct subclass (Holocephali). Is the only chimaera recorded on the Pacific coast of North America.

Distinguishing Characters: The skeleton being of cartilage instead of bone, as in all sharks and skates; the single external gill opening on each side, situated just in front of the base of the pectoral fin, which is covered by a fold of skin; the two dorsal fins; the first with a high, sharp spine at its front edge, the second long and low without spines; the tail tapering to a fine point, with merely a trace of a tail fin; the absence of scales on the body; the teeth being united as bony plates; males with a club-shaped appendage attached to the forehead. **Color:** Silvery with golden and iridescent reflections; the back brownish with many pale spots; pupil translucent greenish blue. The colors fade soon after the fish is taken from the water, giving way to milky whitish or grayish or brownish, with numerous round white spots. Attains a length of between 2 and 3 feet.

Distribution: From Alaska southward to southern California, but not common south of Monterey Bay. Found in shallow water northward, progressively in deeper water farther south.

Importance: Of doubtful possible value commercially, very rarely being seen in California markets. Although an oil of good quality can be produced from the large liver, there are probably not enough of these fish to support an industry.

Notes: The females deposit large eggs enclosed in brown dart-shaped capsules, attaching them to rocks or heavy seaweed with the thread-like end of the egg case. Spawning takes place at all seasons of the year. The young fish remains within the egg capsule during the greater part of a year. Food habits omnivorous.

Unauthorized names: Elephant fish, chimaera.

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